THE BRITISH JOURNAL OF SURGERY

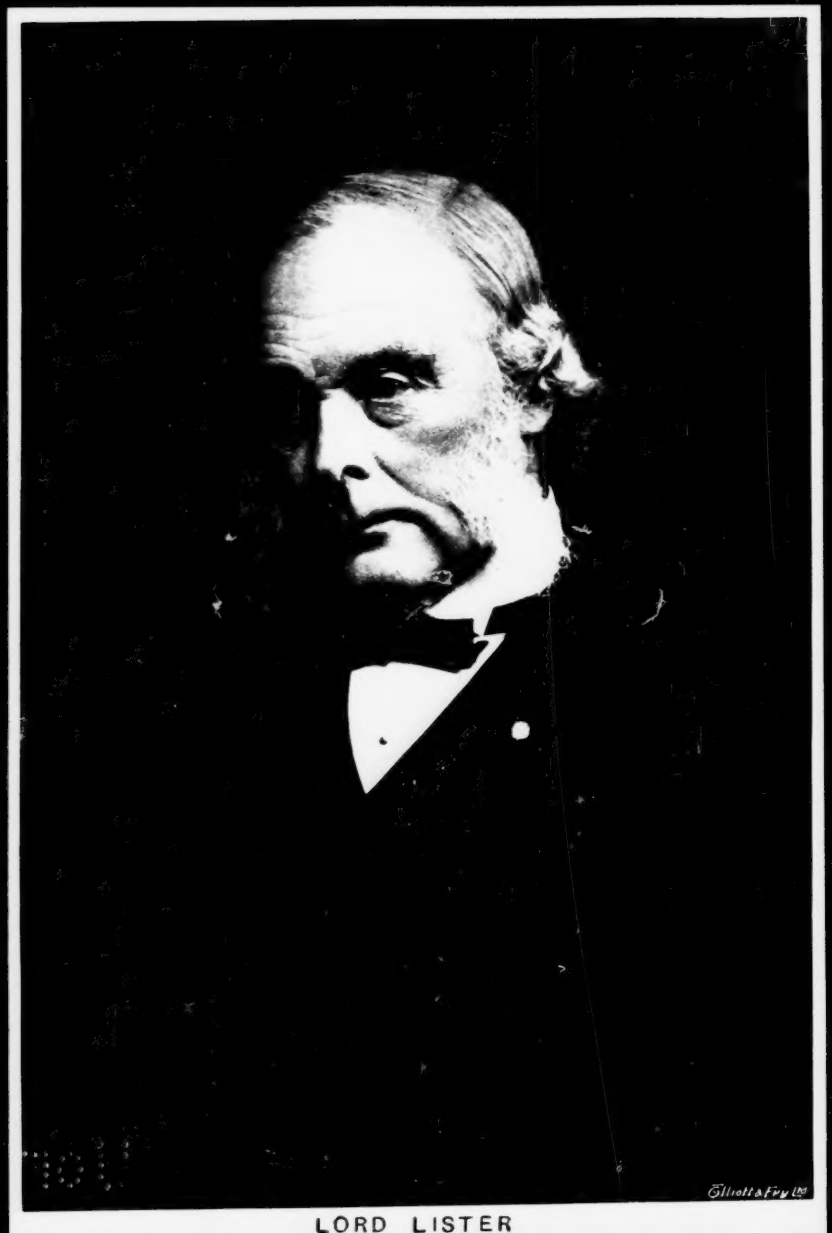
INTRODUCTORY.

THE accident of being for the moment President of the Royal College of Surgeons of England, gives me the opportunity and the honour of writing the first words of this new venture in surgical journalism; of introducing it to the world; advancing its claims; and endeavouring to justify its existence.

Some apology is perhaps called for in these days, when the surfeit of medical literature placed before the enquiring student almost destroys his appetite by its very abundance. But if justification is needed, it may be found in the fact that, while in all other countries in both hemispheres where the study of surgery is most active there are special journals devoted to the subject, in Great Britain alone the progress of surgical thought and enterprise is for the most part only recorded in publications which embrace the whole subject of medicine, and whose pages are largely occupied with general matters of purely local interest. In such surroundings they may well escape the serious notice of our foreign brethren. And yet we are all brothers working hand in hand for the advancement of our Science. But our opportunities, methods of study, habits of thought, and, above all, our modes of expression, are widely different. It is therefore of vital importance that interchange of thought should be made easy, in order that we may all benefit as far as possible by the experience of others, and that our ideas may have the opportunity of acquiring fresh vigour and perhaps yielding a richer harvest by being transplanted into a new, if not a more fertile, soil.

The intention of those who are responsible for this Journal is that it shall include the best, and as far as may be, only the best, British surgical work of the day. It will contain original articles, comments, reviews, and criticisms; and a confident appeal is made to our colleagues, not only in the Mother Country, but in India and the Colonies, to give us their hearty support, and thus to make it worthy of a place amongst the Centralblatts, Archives, and Annals with which we are familiar. With equal confidence a welcome is anticipated from our foreign contemporaries. We look back with justifiable pride to our great English surgeons of the past, and forward with hope that we may maintain our position amongst the advanced guard of surgical investigators, an assurance which is fortified by possessing in the BRITISH JOURNAL OF SURGERY a medium through which we can make our voice intelligibly heard.

RICKMAN J. GODLEE.



LORD LISTER

JOSEPH, LORD LISTER.

1827–1912.

(*See Frontispiece.*)

BORN into a Quaker family, Lister inherited many of the qualities which have rendered members of the Society of Friends successful in business and respected by all with whom they are brought in contact. His originality, his doggedness, his courtesy, and the imperturbability of his temper were clearly inherited qualities. He had the good fortune to be the son of a father who was interested in science, and more especially in that branch of optics which led to improvements in the microscope. Early acquaintance with this instrument rendered him a competent histologist : the training made him observant of minute differences, and enabled him to become a master of detail. Prizes for botany and anatomy soon fell to his share, and rightly, because both sciences are full of detail. The fortunate accident of a congenial teacher led him to study chemistry. Experimental studies with the microscope caused him to consider the processes of inflammation ; daily work in the wards of the hospital directed his attention to the wound suppuration which at that time proved so fatal to patients. The monumental labours of Pasteur showed him that wound fermentation was associated with the access of air and the presence of germs. Means, therefore, were invented for cleansing the air, partly by the carbolic spray, partly by the use of dressings impregnated with substances designed to kill the germs or prevent their passage from the atmosphere to the wound. This was the era of antiseptic surgery as it is generally understood. The lessons of the very old surgeons had been forgotten, that cleanliness, the simplest applications, and the least possible disturbance of a wound, give the best results.

Lister was fiercely attacked, for as yet he had only learned part of the truth. He went on quietly with his work, altering and simplifying his methods, experimenting always and ever modifying, learning by experience that there were other sources than the air for wound infection, learning, too, that his opponents had some sound arguments which must either be explained or adopted. The most important outcome perhaps was the discovery of the absorbent ligature and the value of the rubber drainage-tube. As the whole truth became clear he depended less and less upon the disinfection of wounds, and saw, as all have now learned, that the prevention of microbic infection is better than its cure. His antiseptic system has been replaced by our aseptic methods, but to his work and his devotion in the springtime is due the full harvest which we reap.

Of Lister it has been said that he was the means of saving more lives than all the wars of all the ages had thrown away : a tribute that made a special appeal to his Quaker blood. If service to humanity is the standard by which a man's greatness should be measured, Lister may be acclaimed as among the greatest of men. He it was who made possible all the marvellous advances of modern surgery, and of him one might paraphrase the famous saying of Louis XIV., and declare, " La chirurgie, c'est lui."

RENAL VARIX AND HYPERÆMIA AS CAUSES OF SYMPTOMLESS RENAL HÆMATURIA.

By DAVID NEWMAN, Glasgow.

Much has been done within recent years to reduce the number of unexplained hæmaturiæ, falsely called "functional" or "essential" because the observer has been unable to discover an adequate cause for the bleeding. Gradually more careful and exact methods of inquiry have reduced the number of the unknown, and have furnished explanations formerly unlooked for. "Essential hæmaturia" has been defined by Pilcher as "bleeding from a kidney, arising suddenly, without warning, without discoverable cause, and devoid of symptoms other than the presence of blood in the urine." If the cases be carefully enquired into, some cause will always be found. In 1910 Motz[1] investigated the subject thoroughly, and found only two authentic cases of "essential hæmaturia" on record, one reported by Schade, the other by Klemperer, and even on these some doubt may be cast, as minute lesions in the kidney are very easily overlooked, and many sections are required to exclude their presence. For example, in a case of prolonged hæmaturia operated on by Nicolich,[2] in Vienna an able pathologist pronounced the kidney to be healthy, while in Paris Albarran and Motz found in it a few discrete lesions of glomerulonephritis.

Bleeding from healthy kidneys does not occur. The circumstance that nothing can be discovered on making a section of the kidney while it is still alive or after it has been excised, does not prove that the organ is free from disease; vascular changes, involving increased arterial tension, or obstruction to the venous return, may leave very little evidence, the dividing of the capsule, and the section of the parenchyma, at once relieving the hyperæmia.

On reviewing a large number of cases of renal hæmaturia which have come under observation during the last fifteen years, a goodly proportion have been found to present no symptom beyond the appearance of blood in the urine. A few of these have consequently offered serious difficulties in diagnosis, and have required an exploratory operation to find a satisfactory explanation of the bleeding and a remedy for the disease.

The appearance of blood in the urine during micturition is found in a large number of different lesions of the urinary tract.

In the great majority of hæmaturiæ of a purely surgical nature, the urine indicates in some way the portion of the urinary tract involved by disease. A differential diagnosis of the source of the hæmorrhage may be made: (1) By observing (*a*) the physical characters of the urine and of the blood-clot, (*b*) the admixture of other deposits with the blood, (*c*) the time at which the blood appears in the stream, (*d*) the frequency and duration of the attacks, and (*e*) the effects of movements and exercise, or of complete rest in the course of an attack;

(2) By collecting the urine separately from the two ureters, or by observing blood escaping from the orifice of a ureter; (3) By estimating the quantity of hæmoglobin and comparing it with the amount of albumin in the urine; and (4) By carefully considering all the other accompanying objective and subjective phenomena.

In the cases to be described presently, the only indication of departure from complete health was the presence of blood in the urine. No reason could be assigned for its apparently spontaneous appearance; there was no pain, no other abnormal constituent in the urine, no renal swelling, no *x*-ray shadow, no organisms, and no general interference with health except that due to loss of blood.

Symptomless hæmaturiæ and painless hæmaturiæ have unfortunately been considered in the same category, but it will be easily shown that the latter are a much larger class than the former. For example: many cases of hæmaturia due to impacted calculus, unilateral nephritis, chronic tuberculosis, and tumours of the kidney may not induce pain at any time; but the nature and locality of the disease can be discovered by *x*-ray photography, by bacteriological and microscopic examination of the urine, by cystoscopy, and by the demonstration of some enlargement of the affected organ.

The only cases which can now be properly included under the heading of symptomless hæmaturia are those in which the bleeding is caused by (1) *Renal varix;* (2) *Passive hyperæmia from pressure on, or torsion of, the renal veins;* and (3) *Small growths in the pelvis of the kidney.* At present we will consider only the two first mentioned.

I. RENAL VARIX.

A sufficient number of cases have now been recorded to lead us to recognize renal varix as a distinct pathological entity, and probably in many cases of displaced or of movable kidney the hæmaturia has been due to varicosities of the venous radicles in the medulla or pelvis of the kidney, although the condition has not been recognized at the time.

The history of renal varix is generally as follows. While in the enjoyment of ordinary health, the patient discovers blood in the urine; at first the amount is small and the bleeding lasts for a few days or a few hours, but within a short time the urine becomes loaded with blood, which is uniformly mixed in the urine. Rest or exercise does not influence the amount of blood; clots of blood or blood-moulds of the ureters may be found, and by the cystoscope be seen protruding from the orifice of the ureter.

Blood-shoots escape from one ureter only. The bleeding may last for days, may disappear and recur at short intervals, or may be continuous. It may be present at all times (*Case* 2), or may disappear entirely with rest in bed, to reappear as soon as the patient gets up (*Case* 3).

The quantity of albumin corresponds to the amount of blood, there is no deposit in the urine except blood and blood-casts, there are no tube casts, no infective organisms, no crystals, no shadow is found with *x*-ray photography, and there is no tenderness on pressure over the kidneys.

On cystoscopic examination, the mucous membrane of the bladder may be blood-stained, and clots may be adherent to its walls, but when these are removed

the mucous membrane is seen to be normal, and, if the hæmaturia is active, shoots of bright-red blood are seen escaping from the ureter of the affected kidney. There is no change in the appearance of the ureteric orifices. The shoots are frequently large, and are ejected with some force. On the other hand, the shoots from the neighbouring kidney are few, small, and generally feeble.

Case I.—**Sudden hæmaturia followed by bleedings at irregular intervals during four years; latterly most marked in the mornings. Blood-stained shoots from left ureter. Renal varix. Nephrotomy. Cure.**

Mrs. K., aged forty-seven, came into the Central Home on November 7, 1900, suffering from very copious hæmaturia thought by her family attendant, Dr. Shiels, to be due to a tumour of the bladder. Four years previous to examination a sudden bleeding occurred, but lasted a few days only, and did not recur for two months. The second attack also lasted for a few days, but after the third, hæmaturia came on at irregular intervals, and for the last year the urine had seldom been free from blood. Sometimes the quantity was large, at others only a trace of blood could be seen. Generally the bleeding was most marked in the morning, and the urine cleared up as the day advanced. Beyond the hæmaturia there were no symptoms to indicate the source of the hæmorrhage; no pain, no interference with micturition, no abnormal constituents in the urine except blood and blood-casts, no organisms found by culture or inoculation, no *x*-ray shadow, no swelling in the renal regions, and no mobility of the kidney. Cystoscopic examination showed the bladder to be normal, and that blood was escaping from the left kidney, while the urine coming from the right kidney was clear.

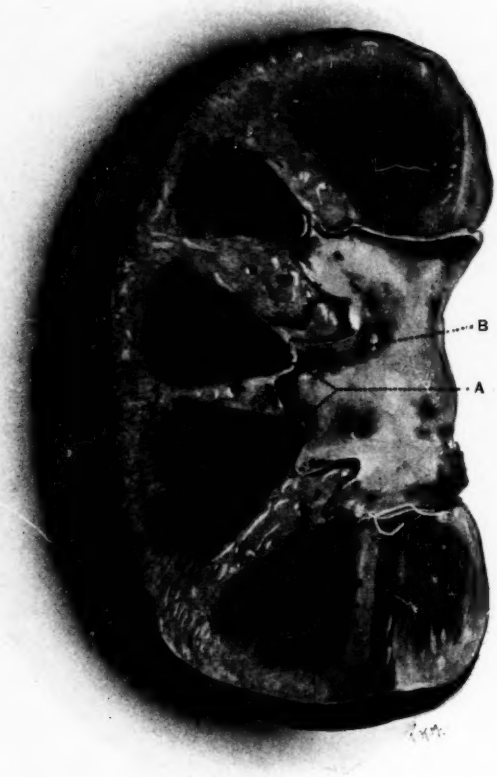


FIG. 1.—LONGITUDINAL SECTION OF KIDNEY, showing marked hyperæmia of pyramids and varix (A) of the apices of the two middle papillæ, and submucous hæmorrhages (B) due to the general hyperæmia, which was more marked when the kidney was in place and whole, than when the substance was incised.

The facts of the case seemed to point to a tumour in the pelvis of the left kidney.

November 26, 1900. Nephrotomy was performed on the left kidney. When the pelvis was opened up no tumour was found, but at the centre of the pelvis a deeply congested area was seen (*Fig.* 1, **A**) involving two pyramids and extending a third of an inch into the medulla. The tissue was of a deep-chocolate colour, and the veins were gorged with blood, while several submucous hæmorrhages were seen (**B**). The two sides of the wound were sutured, and the patient made a good recovery.

The urine remained blood-stained for four days following the operation, but after that the hæmaturia disappeared permanently. She reported herself well on March 2, 1903, but has not been seen since.

Case 2.—**Sudden onset of hæmaturia four months prior to operation. At first, bleeding relieved by rest, but latterly continuous very free hæmorrhage from right kidney. Nephrorrhaphy gave no relief. Bleeding ceased after nephrectomy.**

Mrs. L., aged sixty-four, admitted to the Regent Home on October 29, 1912, suffering from very profuse hæmaturia. The bleeding began suddenly in June; with rest in bed for a fortnight, the urine cleared up, but as soon as she moved about again the hæmaturia returned, and continued for three weeks, which she spent in bed. At this time she suffered neither pain nor frequency in micturition, and, except for the weakness produced by the loss of blood, did not feel unwell. The hæmaturia remained away until the beginning of October. When it returned it

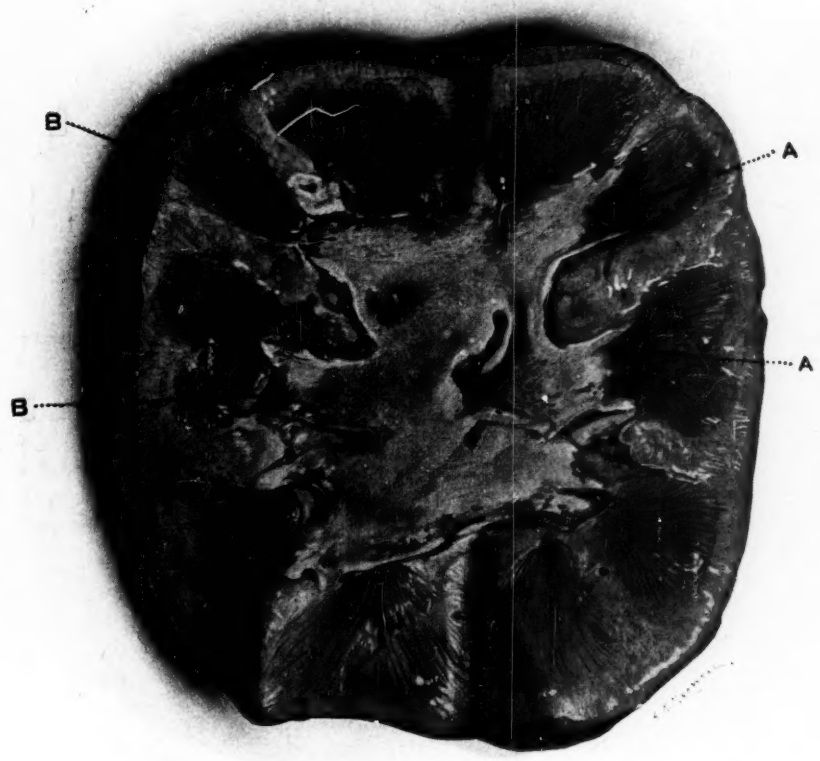


FIG. 2.—LONGITUDINAL SECTION OF THE RIGHT KIDNEY. Very marked hyperæmia of two pyramids (A) (A) at the apices of which distinct varices existed, and extending into the medulla the various capillaries are shown to be much dilated. Numerous submucous hæmorrhages are seen in the pelvis and calices (B) (B^1), and the mucous membrane is injected throughout. Several blood-clots were found in the calices.

was very profuse, and between the tenth and twenty-ninth of October the loss of blood was very great, although the patient was kept at rest, and medicinal measures to control the hæmaturia were adopted.

There were no symptoms beyond the bleeding; no pain, no tenderness or swelling in the left renal region, but the right kidney was displaced and movable. No *x*-ray shadow, no deposit in the urine except blood. No tubercle bacilli or other organisms.

Cystoscopic examination showed shoots deeply stained with blood from the right ureter; those from the left were clear. The loss of blood being very great, and

no relief being obtained by medicinal treatment and rest, it was considered advisable to explore the right kidney. When exposed on the thirtieth of October, it was found to be freely movable. The parenchyma was deeply congested, and in the hilum there was a deposit of firm fibrous tissue infiltrated with fat. It was considered that, as in *Case* 4, probably the displacement of the organ, with the resulting hyperæmia, was the cause of the hæmaturia, and that decapsulation and fixing the kidney would give relief. During the week following the nephrorrhaphy, the bleeding in no way abated, but rather increased, and to prevent death from hæmorrhage it was considered necessary to remove the kidney.

November 6.—The wound was opened up, the kidney was delivered on the loin without difficulty and thoroughly examined, and, no evidence of tumour being found, the pedicle was clamped and the pelvis exposed by an incision along the convex border from pole to pole. The whole of the kidney was congested, and on the points of two of the papillæ were very marked varices, which had ruptured, and from which blood had escaped.

The appearance of the section is shown in *Fig.* 2. The varix is seen to occupy the apex of two of the papillæ (A), and extending into the medulla the venous capillaries are shown to be much dilated, and impart to the tissue a dark-red colour. In the pelvis numerous submucous hæmorrhages (B) are seen, and several blood-clots were found in the calyces.

The patient made a good immediate recovery from the operation, and the hæmaturia ceased; but very unfortunately a venous thrombosis in the left leg occurred, and she succumbed on the twenty-second day after the first operation.

Case 3.—**Hæmaturia resulting from gunshot wound of left kidney. After disappearing for seven years, hæmaturia recurred, and continued so long as the patient was moving about, but was relieved by rest. Displacement of left kidney, marked hyperæmia of medulla, and renal varix. Nephrorrhaphy and decapsulation followed by temporary relief. Nephrectomy followed by cure.**

J. D., aged thirty-one, was admitted to the Royal Infirmary on April 22, 1912, suffering from renal hæmaturia. While serving in South Africa he received a gunshot wound in the region of the left kidney, followed by hæmaturia and a swelling below the left costal margin. The hæmaturia continued for a long time, and a fistula remained in the loin till 1906, when it was closed at the Victoria Infirmary.

After disappearing (the date of which the patient does not remember), the hæmaturia remained away till 1909, when it recurred; at first the bleedings were small in amount, but gradually the quantity became greater, until the weakness, induced by the loss of blood, compelled the patient to give up work. With complete rest the bleedings always stopped, and with exercise they returned.

Palpation showed the left kidney to be displaced slightly downwards, but there was no distinct enlargement. The other organs were strictly normal. Urine, sp. gr. 1020, acid. Albumin, no tube-casts, but blood-casts frequently seen. Blood in large quantity. Urine contained no organisms, and a guinea-pig inoculated on May 1st was killed and found to be normal. No bilharzia. No shadow with *x*-ray plate.

Cystoscopic examination showed the bladder to be normal, and blood escaping from the left ureter only. The shoots from the right kidney were clear.

June 11, 1912.—An exploratory incision showed the kidney to be displaced downwards, rotated so that the lower pole presented forwards, and to be bound down by adhesions. The capsule was split, the adhesions were freed, and the organ was fixed in a normal position. The hæmaturia increased for some days after the operation, and then the urine cleared up and remained normal for over two months, when the hæmaturia recurred as severely as ever. The bleeding disappeared after six hours' rest in bed, but returned as soon as the patient got up.

November 1.—Nephrectomy was performed under considerable difficulty, as a consequence of adhesions produced by the nephrorrhaphy done five months previously. The organ was firmly adherent, the parenchyma deeply congested, and the capsule thickened. After removal, the kidney was incised from end to end,

so as to expose the whole pelvis. Close to the lower pole there was a group of distended veins occupying the apex of the lowermost pyramid (*Fig.* 3, A). They had ruptured, and there were numerous submucous hæmorrhages in the pelvis (B).

Three days after the operation the urine was free from blood and albumin, and has continued so. Dismissed well December 10, 1912.

The records of renal varix or angioma of a renal papilla are worthy of attention, as probably the lesion is a more frequent cause of symptomless renal hæmaturia than has generally been supposed, and one which the surgeon must take into account when operating on such cases.

The first author to call attention to this condition as a cause of symptomless and painless hæmaturia was Fenwick, of London. He[3] reports four cases in which varix of the papillæ was found.

In the first case, the attack came on suddenly during good health, and continued intermittently for five years, occasionally persistent, latterly profuse, at first believed to be due to a stone in the right kidney. Marked anæmia. Jets of dark bloody urine from the left ureter only. Left kidney incised, when a tuft of vessels surrounding the extreme apex of a papilla was discovered. Papillectomy was performed, and cure effected.

In the second case, alarming renal hæmorrhage appeared without apparent cause, and without other symptoms. It was so violent that profound anæmia was induced within three weeks of the onset of bleeding, and demanded immediate operation. Hæmorrhage due to bright-red varicosed papilla. Cystoscopy showed blood issuing from left ureter only. Papillectomy, followed by cure.

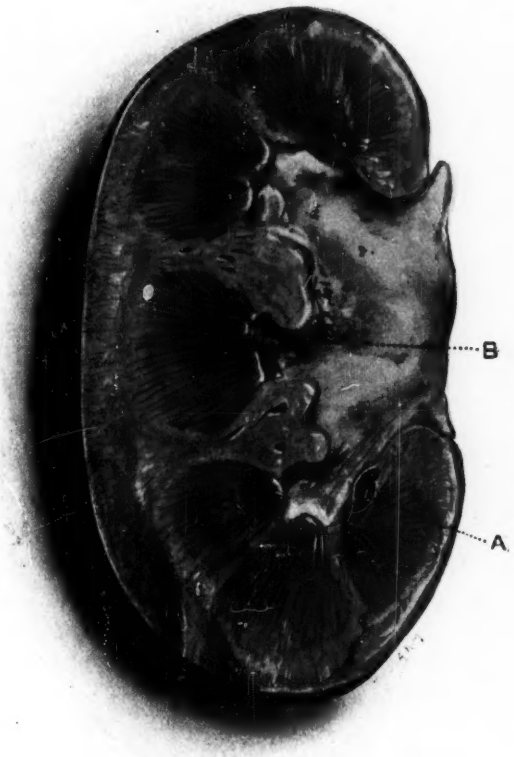


FIG. 3.—LONGITUDINAL SECTION OF LEFT KIDNEY. Very marked hyperæmia of parenchyma before excision, lesion not discovered until after removal. (A) Ruptured view at apex of lowermost pyramid, and numerous submucous hæmorrhages (B) in the pelvis.

Mr. Fenwick says: "In these two cases the papillæ which were affected were got at easily. They were not deeply placed, but just at the opening of the lower infundibulum." In the third case, however, the operation of papillectomy was not suitable, and nephrectomy had to be resorted to.

The patient had profuse hæmaturia, which cleared up after prolonged rest, but recurred in a week or two; profound anæmia suggesting renal carcinoma, but no tumour detected: efflux of blood from right ureteric orifice. Right kidney

fairly movable, cortex normal. Pelvis opened, and iron solution applied to lower infundibulum without benefit. Nephrectomy two months later effected a cure.

Fenwick's fourth case of renal varix also required nephrectomy. The hæmaturia having continued without intermission for two years, without pain or frequency of micturition, a cystoscopic examination proved the blood to be from the right kidney. This was loose, but normal in shape, size, and colour. Section made of cortex of right kidney without result. Nephrectomy, followed by cure. Dissection of kidney displayed dark purple papilla with blood oozing from apex.

W. F. Whitney[4] reported a case of varix involving papillæ very similar to my second case.

The patient was a middle-aged man with a history of repeated attacks of hæmaturia, covering a considerable period. No recognized cause, but hæmorrhage found to be from one kidney, which it was decided to remove. The kidney appeared normal, but "on closer inspection it was noticed that the tips of one or two of the papillæ were reddened at one end and a little spongy." "The microscopic examination showed the small venules, at the tip of the papilla, dilated irregularly to twice or three times their normal size, and covered on their free surface with the finest possible film of connective tissue and a single layer of epithelial cells. Here and there they projected as varicose knuckles above the surface." No thrombi were found. The straight tubules contained blood-corpuscles which were not found higher up than the base of the pyramid, indicating this to be the source of the hæmorrhage.

G. MacGowan[5] records three cases. In the first, the patient's health had been good until four months prior to examination, when the urine became tinged, and thereafter the quantity of blood steadily increased, and was associated with renal colic coincident with "the passage of long strings of blood." Bladder healthy, blood escaped from left ureter, urine from right normal. Nephrotomy, kidney freed from adhesions at upper pole. Section from pole to pole. A few grains of sand found. Blood oozing from pyramid at upper pole. Pyramid removed by wedge-shaped incision, and edges sutured. Slow but complete recovery. Removed piece of kidney "showed nothing but hyperplasia of the blood-vessels."

The second patient suffered from continuous and extremely severe hæmaturia for two weeks. Bladder healthy, emission of blood from left ureter. Kidney exposed and split, and found "normal except a portion of one papilla in the upper pole," which was dark-purple in colour and bled continuously. It was removed by a wedge-shaped incision: the sides were united by one stitch of fine catgut. Cure.

The third case was one of painless and profuse hæmaturia, and the patient lost fifteen pounds in weight. Bladder healthy; jets of blood from left kidney; urine from right kidney contained trace of albumin, but no blood or pus. Bleeding uninfluenced by medicinal treatment. Kidney exposed and incised. Two upper papillæ covered by "moss-like membrane which bled continuously." Papillæ removed, and wound sutured. "The blood-vessels" of the papillæ "are engorged and dilated, and their walls thinned."

Paul M. Pilcher[6] records four typical cases of renal varix. In the first, without known cause blood appeared in the urine, lasted for a month or two,

and then suddenly disappeared. No other symptoms. Hæmaturia reappeared and continued for four years with short intervals only. Cystoscopic examination showed left ureteric opening normal, but the shoots contained blood. Kidney congested and enlarged, bisected along Broedel's line, pelvis and calyces opened, papillæ at lower pole showed minute varicosities. Two halves of kidney sutured and wound closed. Cure.

The second case was of a year's duration, and the hæmaturia was constant and profuse, without other symptoms except frequency of micturition. Cystoscopic examination showed some congestion about the mouth of the left ureter, and the urine escaping from it was bloody, while that from the right kidney was normal. The kidney was exposed, and its pelvis seen to be distended by bloody urine, while the parenchyma appeared congested. On section of the kidney, a typical condition of varix was found. Nephrectomy was performed.

Twenty-four hours after operation the urine passed was clear, but forty hours after "there was sudden dilatation of the heart" causing death. "Examination of the removed kidney showed it to be normal in size, the parenchyma was normal, and no signs of nephritis were present; there was a small cyst in the cortex, filled with clear fluid. Sections were taken from the papillæ, and a typical condition of varix was found; the numerous venous and arterio-capillary spaces were markedly dilated, so that in places there was but a thin wall of cells between a number of blood sinuses, and on the surface the sinuses approached so nearly the mucous membrane that the slightest violence would probably cause their rupture; a rupture of these, however, was not necessary, as a transudation of the blood-cells and of the blood elements would be easy through so thin-walled a vessel if on an exposed surface.

It is emphasized that, macroscopically, nothing whatever was discernible in the kidney to indicate the varicose condition of the papillæ. "I know of no previous case in which the condition has been proved to exist; all the cases reported, as already outlined, have shown macroscopic changes that drew the attention of the operator to one or another of the papillæ, and, in some cases, actually oozing points were seen."

Case three suffered from hæmaturia for four months, and lost twenty pounds in weight: the blood was found to come from the right ureter, which was distinctly abnormal, while the urine from the left kidney was normal. The kidney was found to be displaced and enlarged. Ureter was clamped, and kidney split from pole to pole down to pelvis, and no abnormality found. Surfaces were sutured and kidneys fixed. Hæmaturia disappeared.

The fourth case showed a large amount of blood in the urine, and pain in the left kidney caused by a blood-clot blocking the ureteric orifice: *x*-ray examination negative. The kidney was exposed and bisected, when the uppermost papilla showed tortuous veins beneath the mucous membrane. The two halves of the kidney were brought together, and a complete recovery followed.

II. PASSIVE HYPERÆMIA FROM PRESSURE ON, OR TORSION OF, THE RENAL VEIN.

The pathological and clinical relationship of this class of cases to those just described is very close.

In 1896 attention was drawn, in a paper read before the Clinical Society

of London,[7] to the relationship of renal pain, hæmaturia, and albuminuria to increased vascular tension in the kidney; cases were recorded, and it was shown that the symptoms might be relieved by surgical treatment. Since then a large number of cases of hæmaturia have been seen by the writer, where the bleeding has been the result of displacement or mobility of the kidney, and the condition has been rectified by section, decapsulation, or fixing of the kidney. In the great majority of these cases the bleeding has been associated with pain, but in a few the hæmorrhage was the only symptom. Doubtless if the pelvis had been opened in all these cases, in many of them renal varix would have been discovered. It must be remembered that symptomless hæmaturia is the exception in renal disease; nearly always some other indication of disease shows itself.

It is in displacements, fixed or movable, that symptomless hæmaturia is met with. In writing on the subject of increased vascular tension of the kidney some years ago, the following remarks were made:[8]—

"Interference with the venous return is one with which we are very familiar, and in movable kidney is probably the most frequent cause of pain associated with hæmaturia. This correlation has been observed in over 12 per cent of my cases, and in 7 per cent the hæmaturia has been noted as severe.

"The pathology of these cases is easily understood. It is manifest that in such displacements of the kidney we have to deal with a passive hyperæmia of the organ due to local causes. In some instances the obstruction may be entirely venous; in others, the arterial circulation may also be interfered with. It has been proved by experiments upon animals that when the venous flow is impeded the quantity of blood flowing through the kidney is diminished, and, as a consequence, the amount of urine excreted immediately decreases. Coincident with the diminution in quantity of the excretion, there is a concentration of the urine, which soon becomes albuminous; and, should the hyperæmia be intense, blood-corpuscles, tube-casts, and even blood-casts may appear in the urine.

"As the efferent resistance increases, the veins and the venous radicles surrounding the uriniferous tubules will become distended. This increased resistance to the flow of blood will lead to an augmentation of the blood-pressure within the glomeruli; but, at the same time, by diminishing the total quantity of blood flowing through the organ, the venous obstruction will cause retardation in the excretion of urine.

"The absolute pressure of the blood in the glomeruli is only one factor in determining the quantity of urine excreted; the rapidity of the flow is of even greater importance, and the kidney being provided with a rigid capsule, the engorgement of the veins must produce considerable pressure upon the uriniferous tubules, and so augment the pressure of the fluid in Bowman's capsules. This compensates to some extent for the increased tension of the blood in the Malpighian tufts.

"The backward fluid-pressure of the urine so produced doubtless induces an œdema of the organ, and probably a partial absorption of the already secreted urine, as indicated by an engorgement of the lymphatic spaces; but when the obstruction to the vein is removed, the venous radicles empty themselves quickly, and the œdema rapidly disappears. This happens only when the

engorgement is of short duration; when it is prolonged or frequently repeated, serious structural changes will ensue.

"As regards the passage of albumin and the corpuscular elements of the blood, long ago Mr. George Robinson, in a paper read before the Royal Medical and Chirurgical Society of London, in 1843, demonstrated by experiments upon animals that obstruction to the renal vein caused both albuminuria and hæmaturia, and these abnormal constituents appeared in the urine within a very short time after the obstruction took place—in some instances within three or four minutes. Senator, also, by experiments, proved that, by obstructing the renal vein for a short time in a living animal, albumin and blood-corpuscles could be easily detected in the straight tubules, while Bowman's capsules were free; but if the pressure were more prolonged, the mechanical hyperæmia caused blood to escape into the Malpighian capsules also.

"From these experiments it is easily seen how blood-casts, blood-corpuscles. and albumin may appear in the urine in the cases described above, and from other observations it has been shown that the slower the circulation becomes, the larger will be the amount of abnormal constituents in the urine. Not only does venous obstruction produce those changes in the urine, but compression of the renal artery may also be followed by suppression of the excretion. Hermann and Overbeck demonstrated that even slight disturbance of the renal circulation causes suppression, which may last for a longer or shorter period according to the sensitiveness of the individual, and that albumin and blood may appear in the urine for hours or days thereafter. We also know that arterial obstruction is an important cause of venous hyperæmia; and, with the possibility of having venous pressure combined with arterial disturbance of the circulation, we have in movable kidney a most productive cause of suppression of urine followed by hæmaturia and albuminuria.

"I believe that not only in the cases referred to here, but in many others, the retardation of the glomerular circulation by venous engorgement is the chief factor in the causation of suppression of urine and some forms of albuminuria, and, consequently, relief of tension may give immediate ease to the patient, and restore the function of the kidneys.

"The clinical phenomena can be easily understood when they come to be considered. The impediment to the circulation at once induces swelling of the substance and painful tension of the capsule; this induces degenerative changes in the parenchyma, and if prolonged or frequently repeated, atrophy of the kidney follows. Fortunately, the kidney in the large majority of cases soon resumes its function. The pain compels the patient to go to bed, and while lying, the kidney slips back to its normal position, and the strangulation is for the time relieved."

When hæmaturia is the only symptom, and the patient requires to work, he is less willing to take rest, and goes on from day to day and from week to week until the bleeding becomes serious and causes alarm.

The following is a typical case, and is sufficient to illustrate a moderately common form of symptomless hæmaturia.

Case 4.—**Movable displaced kidney. Hæmaturia at first slight, gradually becoming more severe, and ultimately alarming; blood-casts, but no other casts; no pain or other symptom. Movable kidney not discovered till lately. Decapsulation, nephrorrhaphy, cure. No recurrence of hæmaturia within six years.**

The patient, J.W., aged thirty-five, was sent into the Central Home on October 21, 1904, by the late Dr. John Service, with the history that she had suffered from hæmaturia more or less for three and a half years. In the early spring of 1900 she had a fall from a chair and strained her back, which caused her to rest in bed for a few days. But she made a good recovery and thought no more about it. About a year after, she noticed the urine was red, and taking it to her doctor he told her that it contained blood, gave her a prescription, and advised her to take rest. The blood disappeared in a few days, but the bleeding recurred in about three months, and lasted for ten days or so. The hæmaturia recurred at irregular intervals, but four months previous to examination, the blood suddenly increased in amount, and has been constantly present; was unassociated with any symptom except loss of weight (22 lb. in three months). The bleeding was increased by exercise and diminished by rest, as a rule, but sometimes the urine was as deeply stained after a night's rest as at the end of an active day.

The patient was very anæmic; lungs and heart normal. The right kidney was enlarged and movable, but the left kidney could not be felt. Examination of the bladder showed it to be healthy, and blood was seen escaping from the right ureter only. The shoots from the left ureter were normal. The urine was sterile, contained a large quantity of blood and many blood-casts, produced no effect on inoculation of animals; no *x*-ray shadow was given, and there was no pain on pressure over the kidney.

Complete rest in bed for ten days caused the bleeding to disappear, but it returned as bad as ever on the third day after the patient was up, although she took only a very moderate amount of exercise.

December 1, 1904.—The kidney was exposed, and found to be rotated so that the upper pole pointed inwards and the pelvis downwards, and in the hilum there was a considerable deposit of firm fat and fibrous tissue. The kidney was enlarged, and very deeply congested, but the fibrous capsule was thin and loose, and was very easily separated from the cortex. The pedicle was compressed with a guarded clamp, and the kidney split from pole to pole down to the pelvis, which was carefully examined for tumour, suspected to be the source of the hæmaturia: but none was found, and no point was seen from which the bleeding occurred. Five mattress sutures of catgut were inserted, and the clamp was removed, when free oozing took place from the cut surface, but lasted only a short time. The kidney was then fixed to the parietes, and the wound packed with iodoform gauze. The urine contained blood for four days following the operation, but since then none has been seen. The patient was last heard of in August 1910, and was then in perfect health.

The facts in this case: the presence of blood in the urine derived from one kidney for three and a half years, steadily increasing in quantity until it became alarming, relieved only by continual rest in bed, and not associated with pain or with tubercle bacillus in the urine, or with an *x*-ray shadow, pointed to one of three conditions, renal varix, papilloma or angioma on the pelvis of the kidney, or obstruction to the venous return by displacement of the kidney.

In any case an exploration was demanded, as the patient was rapidly losing ground from the hæmorrhage. No tumour or varix was found, but the kidney was displaced so that the renal vein was twisted, and at the same time the hilum was packed with hard dense fat, which must also have caused some impediment to the venous return. The subsequent relief to the bleeding is no doubt due to the straightening out of the vessels by restoring the kidney to its normal position. In movable kidney, hæmaturia is generally associated with pain

caused by increased tension of the kidney; but in the above case, the fibrous capsule was so loose and thin that expansion of the parenchyma of the organ was freely permitted.

Many similar cases have come under our observation, in some of which the kidney has been exposed, and found to be movable or displaced. The capsule has been separated, the kidney fixed in its normal position, and the operation has been followed by cure. But the pelvis not having been opened, it is not certain whether the hyperæmia of the renal parenchyma was associated with varix, as in *Cases* 1, 2, and 3, or whether the congestion was the sole cause of the bleeding, as in a series of cases of which *Case* 4 is the type.

Pathology.—With reference to the pathology of the cases under consideration, it appears clear that the hyperæmia is passive in all, and is a consequence of venous obstruction, due to torsion of the pedicle of the kidney in movable kidney or fixed displacements, to the development of dense fat in the hilum, or to the pressure of a gravid uterus or an abdominal tumour.

After removal of the kidney, it is not possible by the naked eye to judge the degree of hyperæmia which pre-existed; but on microscopic examination, blood may be seen in the straight tubules, in some instances extending as high as the base of the pyramids. These are the blood-casts found in the urine, as illustrated in *Cases* 1, 3, and 4. The convoluted tubules and the glomeruli may be strictly normal, while the vessels of the papilla and pelvis are greatly dilated, and the venules at the summit may form larger vascular channels distended with blood-clots—renal varix. Fenwick believes that this lesion is most commonly found at the lower pole of the kidney, but the cases recorded are so few that it is not safe to generalize at present. One thing is certain, that the morbid condition is adequate to produce frequent, severe, and in the end prolonged hæmorrhage, sufficiently grave to threaten the life of the patient.

Diagnosis.—In considering the question of diagnosis, the first point to clear up is: Is the bleeding renal in origin, and if so, from which kidney does the blood flow? The second is to ascertain whether the opposite kidney is free from disease.

Although the bleeding is almost constant, difficulty may be experienced and frequent examinations may be necessary, before the blood is actually seen escaping from the ureteric opening. In these cases, as there are no symptoms or physical signs to help him, the cystoscope is of the highest value in enabling the surgeon to know which kidney is diseased. Cystoscopic examinations should be made both during hæmorrhages and in the intervals between them; the clinician should never be satisfied with one observation, however satisfactory and conclusive it may appear. The shoots from the congested kidney are frequent, strong, and small, whereas from the opposite ureter, if its kidney is healthy, the shoots are larger, less forcible, and less frequent. Generally the ureteric opening on the diseased side is altered: it may be small, sharply defined, and the lips injected; or the edges may be swollen, œdematous, and stained with blood; or small blood-clots may be seen adhering to the opening.

When hæmaturia is present, clear bright-red blood escapes from one ureter in a plainly defined stream, and not infrequently the ureter may be seen

distended with blood-clot, which forms a mould of the duct, which may be forced into the bladder by pressure of the hand over the kidney. and followed by the escape of a large quantity of blood which suddenly obscures the view.

With a healthy kidney the ureteric opening is practically always healthy, and the mouth of the ureter may remain normal while the kidney is diseased; indeed, very severe bleeding may be seen passing through a typically healthy orifice. As a consequence, repeated observations must be made before it can be assumed that the blood is escaping from one ureter only.

Having ascertained that one kidney is diseased and the other healthy, and being assured, by watching and by carrying out suitable treatment, that the bleeding cannot be permanently checked by simple means, an exploration should be considered, and, if the conditions are favourable, be made as soon as possible.

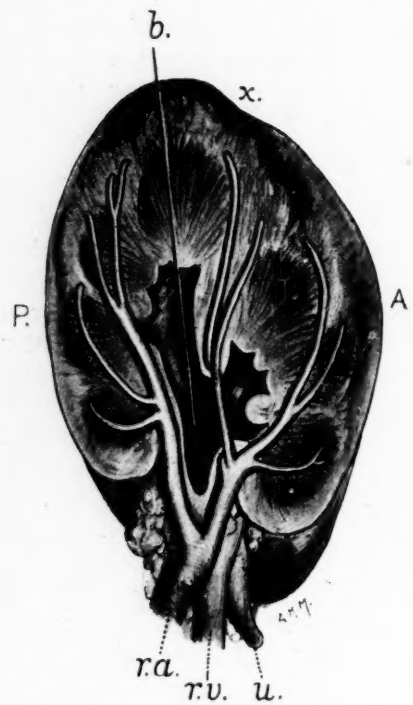


FIG. 4. — The line *b* indicates the incision, half an inch posterior to the middle line of the convex margin of the kidney. *x* The position of the longitudinal column which unites the two segments of the kidney. P. Posterior. A. Anterior. *r.a.* Renal artery. *r.v.* Renal vein. *u.* Ureter.

No doubt passive hyperæmia in the kidney as elsewhere may lead to varices in the pelvis, but it is equally true that in many instances prolonged congestion may exist without the development of any varix.

Treatment.—The effect of complete rest depends upon the cause of the hyperæmia. When it is the result of torsion of the renal pedicle in movable kidney, rest may stop the bleeding for a time; or the relief may be permanent if the rest be prolonged and the kidney settles back to its normal position.

But if rest proves only a palliative, and the bleeding is not cured by medicinal treatment, operative measures must be resorted to in all severe cases.

In cases of passive hyperæmia in movable kidney, decapsulation and fixing the kidney in its normal position may be sufficient.

The line of incision is from the point where the quadratus lumborum meets the edge of the last rib, downwards and forwards to a point on the crest of the ilium $2\frac{1}{2}$ inches posterior to the anterior superior spinous process. The skin, fascia, etc., being divided, the latissimus dorsi and the edge of the external oblique muscles are seen, and should be divided in the same line as the incision through the superficial tissues. The external oblique muscle and the fascia lumborum are thus exposed, and must be carefully divided when the adipose capsule of the kidney is brought into view. When freed from its surroundings, the kidney should be drawn through the wound on to the surface of the loin. Steady traction is required, but force must be avoided.

When the hæmaturia is due to passive hyperæmia of the kidney, simple incision of the cortex, partial separation of the capsule, and fixing the kidney in its normal position may be all that is required to relieve tension and promote a cure. The incision should be made along the convex border a little posterior to the middle line, for a distance of $3\frac{1}{2}$ inches, dividing the parenchyma a quarter or a third of an inch deep, not deep enough to open any of the calices. The fibrous capsule is peeled off so as to expose the raw surface of the cortex, and the cut edges are sutured to the parietes. Gut sutures are also passed through the cortex and fixed to the deep aponeurosis, and the wound is allowed to heal by first intention, no drainage tube or packing being employed.

Incision of the cortex leads to thrombosis of the divided veins, but, on account of the free anastomosis in the venous system, new vessels are soon formed. There may be said to be four divisions of vessels: those at the level of the calices or sinuses, those at the base of the pyramids, those under the capsule, and the perirenal anastomoses. All these anastomoses unite at various levels, connecting the system of one pyramid with those of the neighbouring pyramids.

This operation is suitable in many cases of symptomless hæmaturia arising from passive hyperæmia, but when renal varix exists it may be necessary to open the pelvis of the kidney in order that a complete inspection may be obtained. In exposing the pelvis it is advisable to compress the pedicle with a protected clamp, and it is of importance to avoid dividing the larger branches of the renal artery.

FIG. 5.—LATERAL VIEW OF KIDNEY. *a b*. Convex margin. *x x*. Line of union of two segments of kidney, incision through which would divide vessels of some size. *c d*. Line of incision to open the pelvis with the least bleeding, one third of an inch posterior to the middle line of the convex border of the kidney. (*After* BRÖDEL.)

An anatomical fact of great practical value to the surgeon was pointed out by Hyrtl,[9] namely, that the arterial supply to the anterior and posterior segments of the kidney are completely separate, and do not anastomose with each other (*Fig.* 4, P and A). To this course and distribution of the renal arteries attention has been redirected by Max Brödel,[10] who contributes a most interesting article indicating his views as to the line of incision to be adopted, advantage of which has been taken in the following remarks. At the hilum the artery divides into five or more branches, and about two-thirds of these pass to the anterior segment of the organ. The vessels being end-arteries, there is no anastomosis across the

two divisions of the kidney. The line of separation corresponds to the axis of the posterior row of calices (*Fig.* 5, *a*, *b*). The vessels pass from the hilum in the columns of Bertini, and are largest and most numerous in the central columns. The division of the two arterial systems is fairly marked in most kidneys, but especially in those distinctly lobulated, and may be seen as a slight depression (*Fig.* 4, *x*, and *Fig.* 5, *x–x*) a little anterior to the middle line of the convex border of the kidney. At this line the fibrous capsule is thicker and stronger, and the perirenal fat is more firmly adherent.

It is difficult to pass a knife from the cortex to the pelvis of the kidney unless the cavity is well distended. This may be done by injecting fluid into the pelvis after compressing the ureter.

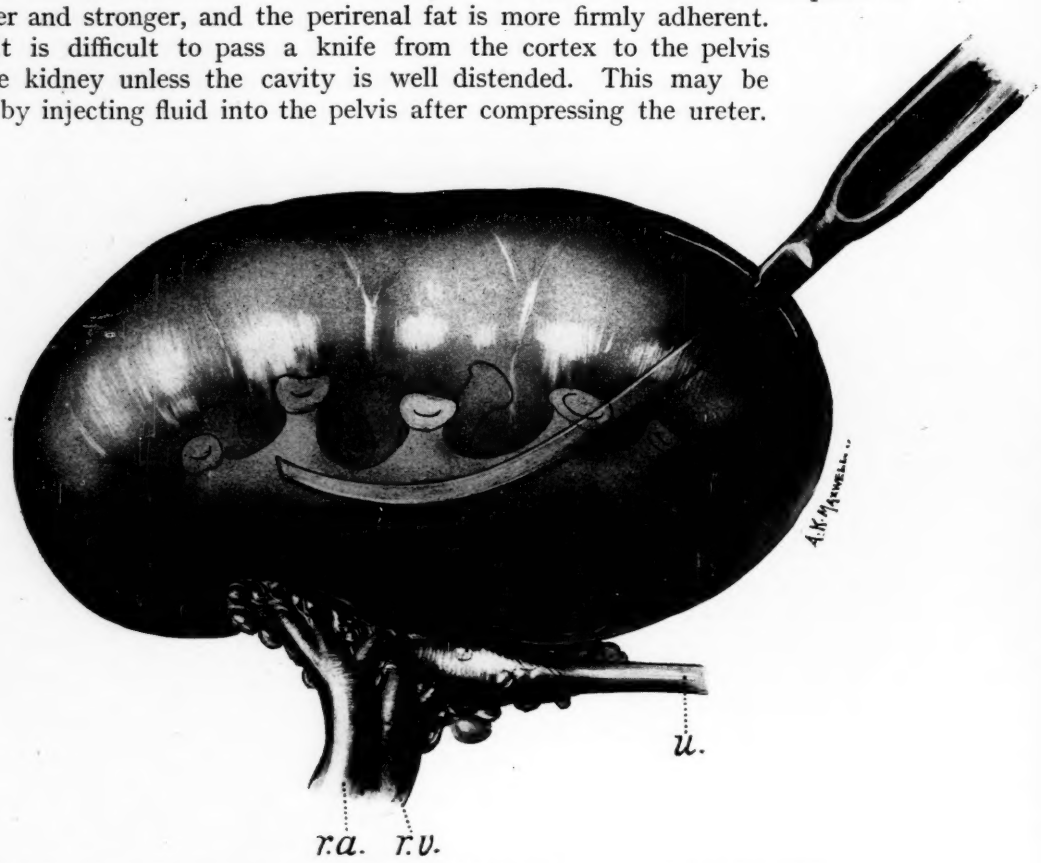


FIG. 6.—Shows the position of the bistoury after it has been passed into the pelvis. The section is made from within outwards. (*After* BRÖDEL.)

An incision having been made into the lower end of the pelvis, the division of the anterior from the posterior segment is best done by blunt instruments. Small-limbed sinus forceps may be used to stretch the wound in order to make a preliminary exploration, and should this prove inefficient a blunt, curved, probe-pointed bistoury (*Fig.* 6) should be introduced and the pelvis opened from end to end. A good view may be obtained. The incision having been made from within outwards, and in the line free from arteries of any size, the bleeding is slight. But even with these advantages the surgeon may fail to detect the bleeding spot, and it may be discovered only after the kidney has been removed, as in *Case* 3.

Based upon the anatomical facts above described, not only has it been advocated that the incision should be made in a given line from within outwards by blunt instruments—the argument being that " the tree-like branches of the arterial trunks " are pushed aside instead of cut through—but it has been proposed to pass a thin silver wire into the pelvis in the long axis of the kidney, and with traction and a sawing movement to divide the tissues from the pelvis to the cortex. Those who have employed this method state that the bleeding is insignificant. Edward H. Richardson[11] describes the method: " By threading the silver wire on a straight liver-needle (Konsnietzoff-Cullen), it could be passed through the kidney from pole to pole, or transversely at any level desired, without wounding any vessels of moment, inasmuch as the blunt flat needle easily pushed aside the vascular trunks lying in its course. With an assistant firmly holding the kidney to prevent undue traction on the vessels at the hilum, the organ was easily divided to any extent desired by a gentle see-saw motion of the wire, with the traction exerted in a cortical direction."

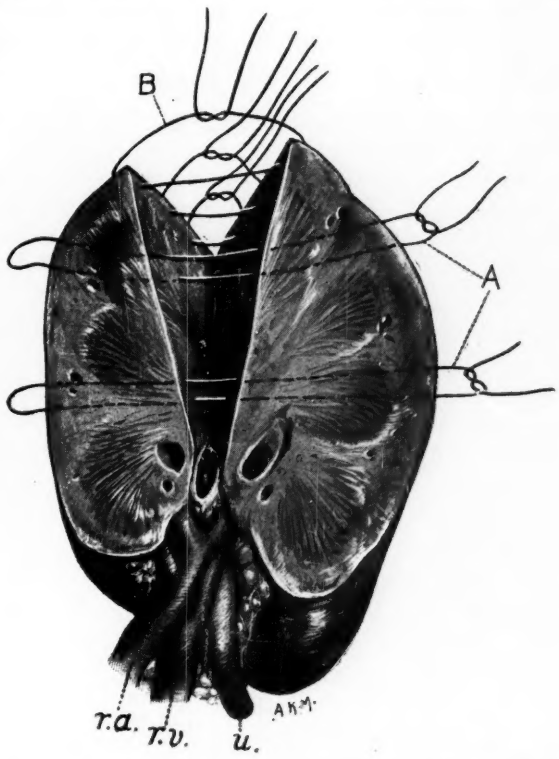


FIG. 7.—SECTION OF KIDNEY, showing the mode of suturing. A. Mattress sutures passed through the substance of the kidney. B. Interrupted sutures uniting the capsule and superficial parts.

This method of operating is suitable for the cases considered in this article where longitudinal bisection of a comparatively healthy kidney is demanded, but it is not an operation to be employed when the kidney is seriously diseased. The kidney having been divided in its whole length and the pelvis exposed to view, the surgeon has to consider how to deal with the varix when it is discovered. In some instances, by simply opening the kidney, the thrombosis of veins following thereon effects a cure. But it is well not to depend upon this happy result; as a rule more requires to be done. Destruction of the papilla by one method or another is necessary, and the most effective is incision, by removing a wedge-shaped section and suturing the cut surfaces with fine catgut. Pyelotomy has been suggested in place of section of the cortex, and has been successfully carried out in a few fortunate cases, but great is the danger of overlooking a renal varix by the small and imperfect view afforded by a direct opening into the pelvis.

In symptomless hæmaturia, when prolonged and grave, nephrotomy is the

operation to be recommended, with incision of the kidney from pole to pole along the convex aspect of the organ, so that a complete examination may be made: (*a*) If a varix be found, it may be curetted or resected (papillectomy); (*b*) If a small tumour be discovered, it can be removed; and (*c*) If the bleeding be due to passive hyperæmia of the medulla, the section of the venous radicles of the kidney causes thrombosis of the cut vessels and new vessels develop at the poles of the kidney.

Nephrectomy is demanded when, by reason of great loss of blood, a rapid bloodless operation is the only one permissible, or when nephrorrhaphy and nephrotomy have been tried and failed. It should not be undertaken as a primary operation, and as a secondary operation it should not be done until the surgeon is satisfied that the remaining kidney is capable of carrying on the demands which will be made upon it.

REFERENCES.

[1] *Ann. d. Mal. d. Org. Genito-Urin.* 1910, i, No. 7.
[2] *L'Assoc. française d'Urologie*, 1911.
[3] E. HURRY FENWICK, *Clinical Cystoscopy*, 1904, 392.
[4] *Bost. Med. and Surg. Jour.*, clviii, No. 21, 797.
[5] *Trans. Amer. Urolog. Assoc.*, iii, 238.
[6] *Surg., Gyn., and Obst.*, xv, No. 1, 59.
[7] NEWMAN, *Clin. Soc. Trans.*, xxx, 65.
[8] NEWMAN, *Movable Kidney*, 1907, 40.
[9] HYRTL, *Topograph. Anat. Wien*, 1882.
[10] BRÖDEL, *Johns Hop. Hosp. Bull.*, xii, No. 118, 10.
[11] *Johns Hop. Hosp. Bull.*, xxi, No. 228, 81.

GALL-STONES:
A PLEA FOR EARLIER OPERATION.*

By D'ARCY POWER, London.

In thinking over the various operations which I have performed at different times, it seemed that the most brilliant as well as the most disastrous results had been obtained from patients who suffered from gall-stones. Brilliant, because from a state of chronic invalidism repeatedly culminating in what is perhaps the most acute pain that can be endured by man, the patient was restored to health and comfort. Disastrous, because in looking through the records of the cases, the mortality is out of all proportion to the exciting cause—a gall-stone. No such mortality is expected, nor would be tolerated, after such an operation as a gastro-enterostomy, a lateral anastomosis, or removal of the appendix, where the peritoneal cavity is of necessity opened; nor after removal of a stone from the kidney or the bladder where the peritoneum remains untouched. Yet the operation for the removal of gall-stones need be no more serious than any of these if it be undertaken at a correspondingly early period. But for some reason the operation of cholecystotomy has never met with the same amount of favour as nephrolithotomy, and patients with gall-stones are left to suffer for years, whilst if the calculus had been in the kidney it would have been removed immediately. In operations for gall-stones, therefore, the surgeon too often operates upon patients exhausted by prolonged illness, or suffering from acute inflammation of a chronically diseased organ, whilst in renal calculus the inflammatory changes are of comparatively recent origin. Many general practitioners still hesitate to advise their patients to undergo an operation for the removal of gall-stones, and recommend palliative measures, which they would not countenance for a moment in the case of a renal calculus. It is difficult to account for this difference of procedure in the operations of nephrolithotomy and of cholecystotomy. The two operations were introduced nearly simultaneously, but perhaps it is the atavistic fear of interfering with the liver, or opening the peritoneal cavity, which has lingered here after it has deserted all the other abdominal organs. The fact remains, however, that even at the present day calomel and large doses of olive oil are still given to patients suffering from gall-stones, in the hope that they will be more readily passed. Such treatment is on a level with that of the lithontriptic period of medicine when Parliament, in 1739, paid Joanna Stephens £5,000 for her stone solvent, which proved to be burnt eggshells and snails with Alicant soap. Horace Walpole gives a caustic little account of it in one of his letters to Horace Mann. He says: "My father has been extremely ill this week with his disorder; I think the physicians are more and more persuaded that it is stone in his bladder. He is taking a preparation of Mistress Stephens's medicine, a recipe of one Dr. Jurin. I made his physician

---

* A Paper read at the Cardiff Medical Society, February 28, 1913.

angry with me by arguing on this medicine, which I never could comprehend. It is of so great violence, that it is to split a stone when it arrives at it, and yet it is to do no damage to all the tender intestines through which it must first pass. I told him I thought it was like an admiral going on a secret expedition of war, with instructions which are not to be opened till he arrives in such a latitude." Our pathological knowledge about vesical calculi has improved; but there are many who are still in the dark ages as regards biliary calculi.

History.—The history of gall-stones is unusually short, since they do not appear to have attracted the notice of medical writers in classical times. There is no doubt that they have always existed, because Prof. Elliot Smith observed a large gall-stone in the mummy of an Egyptian priestess. Rhazes knew that they occurred in animals, although he makes no mention of them as a cause of disease in the human. Gentilis de Foligno noticed them in the thirteenth century, and their origin was discussed, as soon as anatomy began to be studied, by such acute observers as Andreas Vesalius and Fernelius in the sixteenth century. Their surgical treatment was first considered by Maître Jean Louis Petit in 1743. Petit (1674–1760), who was the best French surgeon of his day, and came nearly to our ideal of a first-rate surgeon of the old school, read a most illuminating paper upon "Tumours of the Gall-bladder."[1] In this paper he lays down clearly the diagnosis of gall-stones, and quotes cases which he had seen during the stage of acute biliary colic. He watched the patients for years after their recovery, until their death enabled him to obtain an examination for the purpose of ascertaining the pathological causes and effects of the symptoms he had observed and recorded during the acute attack. He learnt by these means that an inflamed gall-bladder might become adherent to the abdominal wall, that gall-stones might ulcerate into the colon, and that the gall-bladder might be reduced to a mass of fibrous tissue. In this paper, too, he advances the opinion that the gall-bladder may be opened with safety when it has become adherent to the abdominal wall—a fact which could hardly have escaped the notice of contemporary surgeons—but he went a step farther, and advocated the deliberate opening of the gall-bladder for the removal of gall-stones. He states that he had seen such an operation performed accidentally in three cases where the swelling had been mistaken for an abscess of the liver. Two of the patients died, the third recovered. On the analogy of the urinary bladder, from which stones are safely removed by lithotomy, he thought it quite possible to extract biliary calculi from the gall-bladder. He advises, therefore, that the gall-bladder should be punctured with a trocar and canula when it forms a palpable tumour. Some of the bile is withdrawn, and if a gall-stone is felt, a bistoury is passed through the cannula, and the gall-bladder and abdominal wall are divided from within outwards as the bistoury and cannula are withdrawn. The incision should be large enough to admit the surgeon's finger, and the gall-stone is to be removed through the wound thus made. Petit claims that the operation is a new one, and of his own invention; but it does not appear from his paper that he had ever performed it, and, if it was done by his pupils, it must have proved too dangerous for ordinary use, and it soon fell into oblivion.

The modern history of cholecystotomy dates from 1879, when Lawson Tait read a paper on November 11, before the Royal Medical and Chirurgical

Society. The paper is headed, " A Case of Cholecystotomy performed for Dropsy of the Gall-bladder due to Impaction of a Gall-stone."[2] Mr. Lawson Tait introduced his communication with the following remarks: " The great success which has followed the performance of operations for ovarian tumours has led to the extended use of abdominal section in directions which could hardly have been hoped for till within the last few years. My own experience of nearly two hundred cases of abdominal section has been such as to lead me to the conclusion that no abdominal or pelvic tumour ought to be left unexplored if it seems to affect seriously the life and comfort of the patient, unless it be incontestably of a cancerous character.

" Dr. Marion Sims attributes to Dr. Handfield Jones, and I think correctly, the merit of first suggesting that the liver and gall-bladder should be included within the field of surgical practice more fully than they had been up to that point, and particularly that surgical interference should be made in cases where death is threatened from the impaction of a gall-stone.

" To Dr. Marion Sims himself must be given the credit of having followed out this suggestion with his usual boldness and ability, and he himself points out that the case in which he did it was not successful only because the operation was too long delayed. To my good fortune it has fallen to be the first to follow out Dr. Handfield Jones' idea and Dr. Sims' plan successfully."

The patient upon whom this first successful operation was performed was a woman, aged 40, who had suffered for a few weeks from symptoms of gall-stone colic. The gall-bladder was opened on August 23, 1879.

Cases.—The text of my present address consists of ninety cases of disease of the gall-bladder which have been under my observation at St. Bartholomew's Hospital and elsewhere during the years 1900–1912. The first seventy-three patients suffered from cholelithiasis, the remaining seventeen had inflamed gall-bladders which needed surgical interference, the inflammation being due to various causes, but there were no gall-stones. I am indebted to the kind help of one of my dressers, Mr. Edward Brunton, for making abstracts of the notes, and for afterwards writing to the patients to ascertain their condition in December, 1912.

Table A (*p.* 27) contains a short record of the cases, giving the sex, age, duration of symptoms, result of treatment, and a note of the salient features of each case.

Of the total number of ninety cases, fifty-eight were women and thirty-two were men. The age of the patients varied from five years to eighty-two years. The patient aged five was a boy with an empyema of the gall-bladder, who died of a sarcoma of the gall-bladder two months after the operation. The symptoms had lasted from a few days to twenty years or more. Fifty-seven of the patients were jaundiced at some period of their illness; the remaining thirty-three had never suffered from icterus. The gall-bladder was palpable through the abdominal walls in twenty-two cases, and in the remaining sixty-eight it could not be felt. Except in the fattest people, there was a localized tension of the abdominal wall in the right hypogastric region even when there was no localized tenderness. Many of the patients had been treated for very long periods of time; some knowingly for gall-stones; others for indigestion, and a few for ague or some other

form of intermittent fever. All had suffered from attacks of biliary colic ; some so slightly that close questioning alone elicited the history ; others so often, and so severely, that they were at last driven to surgery for relief ; whilst others again had suffered from a single attack of such severity that an operation had to be performed at once, or immediately after it had subsided. None of the attacks were really without warning, in the sense that perforation of a duodenal ulcer occurs without warning, because, when careful investigation was made subsequently, there was always a history of symptoms which, if properly interpreted, would have given a clue to the fact that the patient had been suffering from cholelithiasis for some length of time. The absolutely sudden attacks of hepatic colic in persons who had considered themselves healthy up to the instant of the seizure, proved to belong to the second group of cases in the table where acute infection was found without any gall-stones.

This second group (Nos. 74–90) contained some of the most interesting cases in the series. In only two of the sixteen cases had the patients suffered from gall-stones, the one nine and the other fourteen years previously ; and even in these patients no fresh gall-stones were found at the time of the operation. The exploration of the gall-bladder showed that the symptoms were due to acute or chronic inflammation of the gall-bladder, with or without the formation of pus. The other patients had malignant disease in the neighbourhood of the gall-bladder. One man (No. 87), aged 57, had a round-celled sarcoma of the liver. The sarcoma contained a large cyst which showed evidence of extensive and recent degenerative changes ; another (No. 77)—the five-year-old boy already mentioned—had a spindle-celled sarcoma of the gall-bladder, which at the time of the operation contained five ounces of pus. He died two months later. A man, aged 56 (No. 89), had a greatly distended gall-bladder which contained neither gall-stones nor new growth. He died six weeks later, and the post-mortem examination showed that he had a carcinoma of the duodenum involving the opening of the common bile-duct. A woman, aged 51 (No. 90), had suffered from indigestion for many years, but had never been jaundiced. She had noticed a small, painless swelling in the right hypochondrium for two years. Two months before her admission to the hospital the swelling increased in size, became painful, and she began to lose flesh rapidly. An abdominal exploration showed that the patient had malignant disease of the liver, gall-bladder, and small intestine. She died nineteen days later.

It is interesting to notice that in several cases where great thickening of the tissues near the gall-bladder was observed at the time of the exploration, and a prognosis of cancer was given, the patient is alive and well to this day. Here is such a case : M. M., aged 70, was admitted on account of a painful lump in the right hypochondrium. She had been jaundiced twenty years ago, fourteen years ago, and seven months since, and when she was seen her skin was of a deep yellowish-brown. Examination showed that her abdomen was distended, and that the outline of the small intestine was visible through the parietes. A tumour could be felt just below the 9th costal cartilage on the right side. It was connected to the liver by a stalk, and was hard, irregular, and elongated. The liver itself was natural, but the abdominal cavity contained some free fluid. At the operation, the gall-bladder was found to be enlarged ; it contained blood, degenerated material, and forty gall-stones. The tissues underlying it were so

thickened and adherent, that she was thought to be suffering from cancer. The gall-bladder was stitched to the abdominal wall and drained. The sinus soon closed, and she left the hospital six weeks later. She died of bronchitis two years afterwards without any further symptoms of abdominal mischief. Such cases show that the long-continued irritation of gall-stones may lead to a thickening of the surrounding tissues, such as is known to occur in chronic duodenal ulceration and in some cases of non-suppurative appendicitis. The surgeon should be careful not to give too absolute a prognosis when he meets with such a condition, and the knowledge of its occurrence should make him the more insistent upon the necessity of removing gall-stones as early as possible. It is most likely to occur when the common bile-duct actually runs for some distance in the substance of the pancreas before it opens into the intestine.

Table B (*p.* 32) gives the results of the treatment of gall-stone by surgical methods. The cases fall into three groups—for I have adopted Prof. Kehr's classification, and have added for comparison the statistics which he collected up to the year 1908.[3] *Group I* comprises operations where there were no complications, and the gall-stones were removed easily. *Group II* includes the more difficult cases where there were minor complications to overcome. *Group III* contains all those desperate cases where the operation was one of urgency and left the patient no choice.

Group I.—There is little to be said about the first group. They are analogous to the removal of a diseased appendix during the quiet stage, and the mortality is comparable with that operation. In them the gall-bladder is opened, the gall-stones are removed, the impaction in the cystic duct is slight, and the coats of the gall-bladder are comparatively healthy. The incision in the wall of the gall-bladder can often be sutured at once, and the abdomen closed without drainage. All the patients have done well, whether they were treated in this manner, or by attaching the cut edges of the gall-bladder to the abdominal wall—excluding the skin—and allowing the wound to heal by granulation.

Group II.—In the second class are placed the patients with minor complications—those whose gall-bladders were found to be adherent to the surrounding tissues ; to be shrunken ; fibrous ; thickened ; inflamed, or softened ; to contain mucus or much débris—where the gall-stones were difficult to remove on account of their size, their number, or because they had become so firmly impacted in the bile-ducts as to need considerable manipulation before they could be extracted. The gall-bladder in these cases was always drained, and in many cases the fundus, at least, was removed.

Group III.—The serious complications occurring in the third class were : rupture of the gall-bladder, with or without suppuration, gall-stones lying free in the peritoneal cavity at the time of the operation ; necrosis of the gall-bladder, either wholly or in patches ; where there was perforation of the duodenum or colon resulting from ulceration due to the passage of gall-stones ; where there were symptoms of acute intestinal obstruction with or without the impaction of a gall-stone in the intestine ; where there was an abscess in the neighbourhood of, but not limited to, the gall-bladder ; where there was a co-existing appendicitis, an inflammation of the pancreas, or a thickening of the tissues round the gall-bladder, raising a suspicion of malignant disease ; and, finally, the emergency

cases where the patient was moribund on his admission to the hospital, or where there was serious hæmorrhage, either immediate, reactionary, or secondary.

Table B also gives the percentage mortality of the cases in each group as well as the total mortality of the whole series. In calculating this mortality I have followed the excellent advice offered by Messrs. W. J. and C. H. Mayo,[4] which is, " that in estimating the death rate we have charged as a death from operation every patient who died in the hospital, without regard to the cause of death, or the time which elapsed between the operation and the fatal issue. It includes the patients dying as long as three months after operation, and from intercurrent disease or accidental cause, such as apoplexy, pneumonia, heart disease, chronic nephritis, etc. A percentage of the deaths could be fairly excluded, but as the object is to show the relative curability rather than good statistics, we have concluded that the above method is at least unprejudiced. It undoubtedly has a tendency to exaggerate the dangers of operation, particularly in common-duct disease, where long-continued infections of the bile-passages have resulted in blood changes causing death at a late period. But it also illustrates the dangers of delay and the tendency to produce complications which operation may be unable to relieve." In other words, patients who left the hospital alive are counted as cured. Taking the figures on this principle, the results of my cases show that there was no mortality in the simple cases, for there were twenty-six operations without a death. Three of the patients were men, and twenty-three were women.

There were twenty-seven cases in which the slighter complications were met with, eight being men, and nineteen women. Six died—three men, and three women—giving a mortality of 22·2 per cent.

In twenty cases the complications were so serious that it is probable all the patients would have died unless an operation had been performed. Six were men, who all died ; fourteen were women, of whom five died. The mortality, therefore, was 55 per cent ; but this should be looked upon as 45 per cent saved, and not as 55 per cent dead.

The total mortality of the operable cases, that is to say, of cases operated upon with a reasonable chance of success, was 11·3 per cent; whilst the total mortality of all the cases, taking operable and inoperable together, was 23·3 per cent.

Prof. Hans Kehr, of Halberstadt, has collected the statistics of gall-stone operations from all sources published to the end of the year 1908.[3] He finds, following the system of classification which I have adopted from his tables, that :—

1. 2,494 simple gall-stone operations have been performed, with a mortality of 3·6 per cent, for there were eighty-nine deaths.

2. 341 patients were operated upon where there were slight complications, and of these forty-seven died, giving a mortality of 13·8 per cent.

3. 408 patients had severe complications, of whom 250 died, giving a mortality of 61·3 per cent.

He concludes, therefore, that there were 2,653 operable cases of gall-stones, with a mortality of 5·9 per cent ; whilst the total mortality of operable and inoperable cases together was 12·9 per cent, since 3,254 cases are recorded, with 422 deaths.

TABLE A.—CASES OF OPERATIONS ON THE GALL-BLADDER BY D'ARCY POWER, F.R.C.S.Eng.

No.	Sex	Age	Duration of Symptoms	Result	Remarks
1	M	56	Five years	*R	Jaundiced, increased resistance over region of gall-bladder: 35 gall-stones: gall-bladder sutured.
2	F	70	Two years	R	No jaundice: palpable tumour: one gall-stone weighing an ounce, much mucus and bile: gall-bladder sutured.
3	F	46	Three years	R	No jaundice: repeated biliary colic: one large gall-stone: gall-bladder drained.
4	F	62	Thirteen years	R	Jaundiced: repeated biliary colic: 27 gall-stones: gall-bladder drained.
5	F	27	Twelve months	R	No jaundice: repeated colic: one gall-stone: gall-bladder small and shrunken: gall-bladder sutured.
6	F	—	"Since childhood"	R	No jaundice: repeated colic: one gall-stone weighing an ounce: gall-bladder sutured.
7	F	71	Twelve years	R	Jaundiced: repeated colic: resistance over region of gall-bladder: 6 large gall-stones: gall-bladder sutured.
8	F	22	"Some months"	R	No jaundice: repeated colic: one gall-stone as large as a walnut: gall-bladder sutured.
9	M	52	Twenty years	R	Jaundiced: repeated colic: palpable tumour: two gall-stones: gall-bladder thickened and suppurating: gall-bladder drained.
10	F	50	Eight years	R	Jaundiced: repeated colic: 8 gall-stones: gall-bladder contracted, very adherent to colon and duodenum: gall-bladder drained.
11	F	49	Six months	**D†	Jaundiced: repeated colic: 1 stone: gall-bladder small and contracted. Death from collapse same day.
12	M	45	Two years	D†	Jaundiced: repeated colic: has passed 6 gall-stones: 96 stones removed: gall-bladder sutured. Death from peritonitis four days later.
13	M	42	Three years	D†	Jaundiced: repeated colic: gall-bladder undiscoverable. Death from collapse three days later. P.M. very fat: gall-bladder shrivelled: surrounded by adhesions: contained a few drachms of green pus and a gall-stone at junction of cystic and hepatic duct.
14	F	46	Ten months	R	Continued jaundice: 54 gall-stones: mass of disease felt behind gall-bladder: (?) pancreatitis: gall-bladder drained.
15	M	68	Eight years	D†	No jaundice: palpable tumour: gall-bladder thought to be malignant mass and not opened. Died of bronchitis 13 days later. P.M. gall-bladder contained many gall-stones: calculus at junction of cystic duct and neck of gall-bladder: common bile-duct obstructed by several small gall-stones.
16	M	48	(?)	D†	Traumatic rupture of gall-bladder softened by cholelithiasis: gall-stones free in peritoneal cavity. Death same day.
17	F	53	Nine years	D†	Repeated colic: at operation large abscess of gall-bladder opening into duodenum, one faceted gall-stone in abscess. P.M. many secondary deposits, walls of abscess cancerous.
18	M	82	Several years	D†	Deeply jaundiced: gall-stones: pancreatitis: no operation. Died two days after admission.

*R = Recovery. ** D† = Died before leaving the hospital.

CASES OF OPERATIONS ON THE GALL-BLADDER—*Continued.*

No.	Sex	Age	Duration of Symptoms	Result	Remarks
19	F	47	Eight weeks	R	Palpable gall-bladder: slight jaundice: eight gall-stones removed: gall-bladder drained.
20	M	42	Six months	R	Not jaundiced: a greatly thickened gall-bladder containing a large friable gall-stone removed piecemeal: gall-bladder drained.
21	F	48	Nine weeks	D†	Palpable tumour: constant pain since first onset of symptoms: jaundiced: gall-bladder a mass of dense fibrous tissue containing one large round stone. Death two days later after hæmorrhage: prolonged P.M. examination failed to show cause of death. Very fat.
22	M	40	(?)	D†	Admitted moribund with general peritonitis: abscess in region of gall-bladder: gall-stones free in peritoneal cavity.
23	F	40	Ten years	D†	Jaundiced: fundus of gall-bladder removed with 2 gall-stones: many adhesions between gall-bladder, colon, and liver. Death from asthenia one month later.
24	F	75	Many years	R	Appendicitis and cholelithiasis.
25	M	60	Several years	D†	Jaundiced: admitted with acute obstruction of one week's duration: ileo-colostomy. After death hepatic and common bile-duct filled with gall-stones.
26	F	35	Ten months	D†	Jaundiced: fundus of gall-bladder removed with one large stone: gall-bladder adherent to colon and duodenum. Death 48 hours afterwards. P.M. many small abscesses round bile-ducts: a sloughy cavity connected with the duodenum.
27	F	73	Fourteen days	R	Jaundiced: gall-bladder palpable: 183 small stones removed: pus in gall-bladder: much thickening behind gall-bladder, which was drained. (Death 2½ years later.)
28	F	40	Fourteen years	R	No jaundice: gall-bladder palpable: 9 stones removed: gall-bladder drained. (Survived 3 years, and died of acute bronchitis.)
29	F	40	Fourteen years	R	No jaundice: gall-bladder palpable: refused operation.
30	F	68	Five years	R	Slightly jaundiced: gall-bladder palpable: one stone size of a hazel nut removed from enlarged and inflamed gall-bladder: gall-bladder drained.
31	F	70	Twenty years	R	Jaundiced: tumour palpable: 40 gall-stones: many adhesions: much thickening at back of gall-bladder: blood and degenerated material in gall-bladder.
32	F	36	One year	R	Repeated colic: no jaundice: one gall-stone in dilated cystic duct: gall-bladder filled with clear mucus: gall-bladder drained.
33	F	39	One year	R	No jaundice: fundus of gall-bladder a mass of fibrous tissue: several faceted stones removed from cystic duct: fundus removed: drained.
34	F	43	Five weeks	R	No jaundice: gall-bladder palpable: 34 gall-stones removed: pus at base of gall-bladder: then mucus: then calculi: drained.
35	F	48	Eight months	R	No jaundice: one gall-stone in contracted gall-bladder: bound down by adhesions: drained. Given a belt. (Alive and well five years later.)
36	F	66	(?)	R	No jaundice: several small gall-stones and much thick pus removed from gall-bladder: drained.
37	F	54	Many years	R	Slight jaundice: gall-bladder palpable: several small stones removed from necrosing gall-bladder: fundus removed: drained.

CASES OF OPERATIONS ON THE GALL-BLADDER—*Continued.*

No.	Sex	Age	Duration of Symptoms	Result	Remarks
38	F	47	Fourteen years	R	No jaundice: gall-bladder palpable: many small stones and fundus of gall-bladder removed: drained.
39	F	43	Eight years	R	Jaundiced: refused operation.
40	F	50	Seven months	R	Jaundiced: 16 gall-stones and fundus of gall-bladder removed: many adhesions. ($2\frac{1}{2}$ years later in good health, no further attacks.)
41	F	44	Seven years	R	No jaundice: gall-stones and fundus of gall-bladder removed: difficulty in stopping hæmorrhage: wound plugged.
42	F	53	Three years	R	Jaundiced: 23 gall-stones: gall-bladder drained. (Well two years later, no recurrence of colic.)
43	F	74	Twenty years	R	Jaundiced: palpable gall-bladder: 50 gall-stones and an ounce of pus in gall-bladder: drained. (Died 15 months later, no return of colic.)
44	M	54	Nine months	R	Jaundiced: 3 gall-stones pushed into duodenum: gall-bladder not opened. (3 years later, no return of colic: excellent health: wears belt for hernia.)
45	M	33	Six years	R	Jaundiced: 4 stones and fundus of gall-bladder removed: gall-bladder much contracted. (No return of colic after sixteen months: health excellent.)
46	M	25	A few days	R	Sudden violent onset of pyloric pain with rigid abdomen: fundus of gall-bladder removed: pus and one gall stone: drainage.
47	F	72	Four years	D†	Jaundiced: repeated colic: several small stones. Died of cholæmia five days after operation.
48	F	40	Two years	R	Jaundiced: repeated colic: two calculi: pus: gall-bladder drained.
49	M	70	Eight months	D†	Jaundiced: repeated colic: a large mushroom-shaped calculus: gall bladder sutured. Death from hæmorrhage into bowel 48 hours later.
50	M	36	Three years	R	Not jaundiced: repeated colic: palpable tumour: many gall-stones and pus in gall-bladder: drained.
51	F	48	Many years	R	Not jaundiced: palpable tumour: no typical biliary colic: over 600 calculi of varying sizes removed: gall-bladder drained.
52	F	32	Three months	R	Not jaundiced: increasing colic: three gall-stones: drainage.
53	M	66	Several years	D†	Jaundiced: one small gall-stone. Death from interstitial pancreatitis and cancer of liver 6 months later.
54	F	62	Sixteen months	R	Jaundiced: repeated colic: several stones removed: fistula: fundus of gall-bladder removed by secondary operation and cholecystenterostomy. Cure.
55	F	72	Several years	D†	Not jaundiced: no typical colic: intestinal obstruction 12 hours: large gall-stone removed from upper part of jejunum. Death from collapse same night. Very fat.
56	F	55	Twelve months	R	Not jaundiced: palpable tumour: declined operation: appendix removed 18 months since.
57	F	70	Nine months	D†	Jaundiced: repeated colic: gall-bladder explored: no stones found. Death 18 days later. Very fat. P.M. dense adhesions round contracted gall-bladder: common bile-duct contained 4 small calculi and right hepatic duct 1: no biliary obstruction: great fæcal impaction.
58	F	50	Five weeks	R	No jaundice: palpable lump: no colic, only dull pain: gall-bladder distended with mucus: two stones, one blocking cystic duct: drained.

CASES OF OPERATIONS ON THE GALL-BLADDER—*Continued.*

No.	Sex	Age	Duration of Symptoms	Result	Remarks
59	F	46	Five days	R	No jaundice: sudden attack of pain with intestinal obstruction: gall-stone removed: extensive thickening of gall-bladder, liver, and colon: inoperable carcinoma. Discharged to a home three weeks later.
60	F	55	Four years	R	No jaundice: no typical colic: 3 large calculi removed from a thickened gall-bladder distended with mucus: appendix had been removed 3 years, and both breasts for carcinoma 10 and 9 years ago: recurrent axillary glands removed 8 years ago: hæmorrhoids tied 4 years ago: wore a belt for movable kidney 18 months.
61	F	45	Fourteen years	R	No jaundice: severe colic: palpable tumour. Many gall-stones removed from a contracted and adherent gall-bladder containing mucus and afterwards muco-pus. Cholecystectomy had been performed 14 years previously, when 4 gall-stones were removed. Drainage each time.
62	M	33	Six years	R	Jaundiced: palpable tumour: severe colic two days before admission: 4 stones removed from a gall-bladder surrounded by recent adhesions. Cholecystectomy: drained.
63	M	53	Thirty-one years	R	Not jaundiced: increasing colic: localised tenderness: gall-bladder small, tightly adherent, filled with tough mucus: containing 3 stones. Cholecystectomy: drained.
64	M	41	Many years	R	Not jaundiced: all his life dyspeptic: seized with sudden pain on the day of the operation; gall-bladder adherent to surrounding structures: a few small gall-stones squeezed along duct.
65	F	46	Seven months	R	Jaundiced: colic: refused operation.
66	F	50	Eight weeks	R	Jaundiced: colic: very fat: no tumour palpable: 1030 calculi removed, 7 measuring ¾ in.: drained.
67	F	46	Six months	R	No jaundice: colic: 2 large gall-stones and fundus of gall-bladder removed: appendicectomy at same time: no drainage.
68	F	49	Three years	R	Jaundiced: repeated colic: 28 gall-stones: drainage.
69	F	56	Some months	R	Jaundiced: several gall-stones: pus in gall-bladder; drainage.
70	F	38	2½ years	R	No jaundice: 4 gall-stones removed: drainage.
71	F	32	Five years	R	No jaundice: palpable lump; 138 gall-stones removed: drainage.
72	M	60	Six years	R	Jaundiced: repeated attacks: 102 gall-stones removed: drainage.
73	F	46	Seven months	R	No jaundice: gall-bladder palpable: pus: mucus: one large gall-stone: drainage.
74	F	57	Twelve years	R	Passed 3 gall-stones 9 years ago: repeated attacks of pain during last four months: many adhesions: no gall-stones.
75	F	35	Two years	R	Constant pain, with localized hypogastric tenderness: cholecystectomy: mucous membrane of gall-bladder like a strawberry.
76	F	30	Three weeks	R	Very jaundiced: palpable swelling: gall-bladder distended and inflamed: no stones: drained.
77	M	5	Three months	D†	Jaundiced: palpable swelling; 8 ounces of pus in gall-bladder. Death 6 weeks later from spindle-celled sarcoma of gall-bladder.

CASES OF OPERATIONS ON THE GALL-BLADDER—*Continued.*

No.	Sex	Age	Duration of Symptoms	Result	Remarks
78	M	22	One month	R	Ailing since influenza 2½ years ago: no jaundice: tumour palpable: 8 ounces sterile pus evacuated from liver near gall-bladder.
79	M	29	Ten years	R	Jaundiced: stone removed 4 years previously: gall-bladder very distended and adherent: no stone: cholecystectomy.
80	M	28	Three years	R	Jaundiced: pain in hypogastric region: general distention: gall-bladder nothing abnormal detected.
81	M	59	Five years	R	Jaundiced: palpable swelling: gall-bladder full of pus: drainage.
82	M	42	One week	R	Jaundiced: gall-bladder inflamed, thickened: full of pus: drainage.
83	M	40	Four months	R	Jaundiced: gall-bladder inflamed and thickened: no gall-stones or pus.
84	F	58	One year	R	Very jaundiced: gall-bladder distended, but no cause found: drainage.
85	F	49	Four years	R	Jaundiced: gall-bladder full of foul-smelling bile, from which a pure culture of *B. coli* was obtained: drainage. (Well 20 months afterwards.)
86	M	63	One month	D†	Jaundiced: common duct surrounded by new growth, which also involved pancreas.
87	M	57	Seven months	D†	Jaundiced: large swelling in epigastrium: operation showed it to be a round-celled sarcoma containing a large cyst.
88	F	37	Six weeks	D†	Jaundiced: malignant growth in head of pancreas: distended gall-bladder. Death a fortnight later.
89	M	56	Ten weeks	D†	Jaundiced: palpable swelling: gall-bladder greatly distended: no stones or growth. Death six weeks later. Carcinoma of duodenum: two secondary nodules in liver.
90	F	51	Two years	D†	No jaundice: palpable swelling. At operation malignant disease of liver, gall-bladder, and small intestine discovered. Death 19 days later.

TABLE B.—STATISTICS OF GALL-STONE OPERATIONS.

* Refused operation. † Died. The numbers refer to the cases in *Table A*.

I. Simple Gall-stone Operations			II. Complicated Gall-stone Operations						Results of I and II(*a*).			Total Results.		
Sex		Results	(*a*) Slight		Results	(*b*) Serious		Results	Sex		Total	Sex		Total
Male	Female		Male	Female		Male	Female		Male	Female		Male	Female	
No. 1	No. 2	26 0†	No. 9	No. 5	21 6†	No. 16†	No. 15†	9 11†	8 3†	39 3†	47 6†	8 9†	48 8†	56 17†
,, 20	,, 3	=0%	,, 12†	,, 10	=22·2%	,, 18†	,, 17†	= 55%	=27·2%	=7·1%	=11·3%	=52%	=16·6%	=23·3%
,, 72	,, 4		,, 13†	,, 11†		,, 22†	,, 23†							
	,, 6		,, 49†	,, 14		,, 25†	,, 24							
	,, 7		,, 50	,, 21†		,, 47†	,, 26†							
	,, 8		,, 62	,, 32		,, 53†	,, 27							
	,, 19		,, 63	,, 33			,, 31							
	,, 28		,, 64	,, 34			,, 37							
	,, 29*			,, 35			,, 54							
	,, 30			,, 36			,, 55†							
	,, 38			,, 40			,, 59							
	,, 39			,, 41			,, 60							
	,, 42			,, 43			,, 61							
	,, 44			,, 45			,, 67							
	,, 51			,, 46										
	,, 52			,, 48										
	,, 56*			,, 57†										
	,, 65*			,, 58										
	,, 68			,, 66										
	,, 69													
	,, 70													
	,, 71													
	,, 73													
						KEHR'S STATISTICS.								
377 40†	2104 81†	2494 89†	53 11†	282 34†	341 47†	111 75†	278 168†	408 250†	415 48†	2220 107†	2653 158†	526 123†	2494 275†	3254 422†
=10·6%	=3·8%	=3·6%	=20·8%	=12·1%	=13·8%	=67·6%	=60·4%	=61·3%	=11·6%	=4·8%	=5·9%	=23·4%	=11%	=12·9%

Commentary.—The first point which arises from a study of the two tables which are here offered for consideration is the frequency with which gall-stones occur. It is clear that they are not rare in London, if a single general surgeon like myself operates upon eight or nine cases a year ; because for one patient who is operated upon, there must be at least ten who suffer from gall-stones and are allowed to go without surgical intervention. The incidence of cholelithiasis varies somewhat in different parts of the world. Dr. Rolleston[5] says that " in routine post-mortem work gall-stones are usually found in 10·5 per cent of the subjects. In 10,866 cases, obtained by combining the figures of Roth, Schloth, and Schroeder, gall-stones were present in 1,029 or 9·4 per cent. This agrees with Kehr's statement that one-tenth of the adult German population is affected with cholelithiasis. In America and England the percentage is lower. In 1,655 American cases there were 115, or 6·9 per cent, with gall-stones. At the Middlesex Hospital, Voelcker found gall-stones in 8·5 per cent ; and Colwell, at a later period (1900–1904), in 5·4 per cent ; Brockbank, at Manchester, found 101 cases of gall-stones in 1,347 necropsies, or 7·4 per cent. At St. George's Hospital there were 268 in 4,616, or 5·8 per cent. Among 4,544 necropsies in India (93 per cent on natives and 7 per cent on Europeans), Rogers found 233, or 5·4 per cent, with gall-stones."

It is clear that many of these gall-stones gave rise to such slight symptoms as to cause them to be overlooked. It is well-known, too, that gall-stones are often passed spontaneously, or as a result of adequate medical treatment. The surgeon cannot, and should not, interfere under these conditions ; but a large residuum of cases remains which ought to come under his care at a very much earlier period than is now the custom. Indeed, the second point, which is brought into prominence by *Table A*, is the extraordinary patience of those who suffer from gall-stones. The duration of the symptoms in many cases has been " for years ; " " from childhood ; " " for eighteen months ; " very rarely for days or weeks. The patients have suffered during these long periods from repeated attacks of gall-stone colic, with or without jaundice. They have had constant dyspepsia, and they have frequently had local tenderness in the right hypochondrium. Their patience has been fortified in too many cases by their doctors—sometimes from a natural reluctance to recommend what seemed to them a hazardous operation ; sometimes from that habit of procrastination which so often governs the treatment of disease when the symptoms are intermittent and only occasionally severe ; sometimes, and I am afraid rather frequently, from an error in diagnosis. There seems to be a general impression that gall-stones cannot be present without jaundice or biliary colic, and this leads to the treatment of symptoms, when a physical examination would quickly clear up the cause of the patient's continued ill-health. It cannot be insisted upon too strongly, therefore, that dyspepsia with flatulence and occasional attacks of ill-defined pain demands a physical examination of the abdomen, and not the bottle of physic containing gentian, rhubarb, or bismuth, which is generally prescribed and repeated for long periods of time.

When gall-stones are present, examination of the abdomen often reveals a tender spot in the right hypochondrium, at a point which is too high for the pain of appendicitis, whilst it differs from that of a pyloric or duodenal ulcer, because in these conditions the pain is not felt until the inflammatory condition has

penetrated to the peritoneal coat, or in other words, until the ulcer has begun to leak. In these cases there is often a second point of tenderness in the right and, perhaps, the left iliac regions, so that a patient may be operated upon for appendicitis, or for a left pericolic abscess, when in reality *she* is suffering from gall-stone, or *he* has a leaking duodenal ulcer. The localized tenderness over the region of the gall-bladder is naturally associated with some rigidity of the upper part of the right rectus abdominis muscle, and even when tenderness is not a marked feature, the slight tonic contraction of the muscle can be detected by a careful and gentle observer if the patient is sufficiently thin to allow the abdominal muscles to be felt. The localized tenderness and rigidity are naturally best marked when there has been recent inflammation of the gall-bladder, although skilled palpation will reveal it in most of the cases where the patient has suffered from painful flatulent dyspepsia, which operation afterwards shows was associated with gall-stones. It is not probable that a mistaken diagnosis will be made when the patient has had a well-marked attack of biliary colic, because the symptoms of gall-stone colic are characteristic, and cannot be better described than in the words of Sir Berkeley Moynihan,[6] who says :—

> The symptoms caused by the impaction of a stone in the cystic duct are quite characteristic. There is probably a sense of gastric uneasiness, with flatulence, belching, and a sense of distention, as is so often the case in the cholelithic patient after meals. Quite suddenly, however, often with onset as instant as if he were stabbed, the patient is seized with the most acute pain, felt across the epigastrium, often more on one side than the other, and nearly always through to the back, near the tip of the right shoulder. The agony may be terrific, and the patient may reach the very limit of human endurance. He is infinitely restless, and in this differs from the rigid and motionless patient who has suffered the perforation of a gastric or duodenal ulcer. He is moaning and moving without pause, pressing the body with one hand or both, or bending over a chair or clutching a hot bottle to the abdomen. He sweats and yet feels cold and clammy. He breathes with difficulty, owing to a spasm of the diaphragm, which, like the other abdominal muscles, is tightly contracted to form that firm muscular splint whose purpose it is to keep at rest and free from harm a lesion in need of protection. Nausea, and nearly always vomiting, occur, and vomiting may cause relief, probably by reason of the muscular relaxation which it induces. Very often the pain disappears with absolute abruptness. One moment the patient writhes in agony, the next he smiles in relief. The instant beginning and the instant cessation are characteristic of cystic-duct obstruction—they never occur in any other form of gall-stone obstruction with anything like the same precision. The pain is almost always referred to the back, and Boas' sign can often be elicited in and after a seizure. If an attack last for some hours, the distended, tense, and tender gall-bladder may be felt. It is often exquisitely sensitive, and may remain so for many days. The importance of tenderness along the lower border of the liver in cholelithiasis was first indicated by Naunyn, who wrote that, in patients who have recently suffered from an attack of colic, " pain is induced when, during a deep inspiration, pressure is made with the hand as far upwards as possible beneath the right costal border. At the moment when the liver impinges upon the tips of the fingers the patient experiences a deep-seated pain."

No patient should be allowed to pass through the ordeal of repeated attacks of biliary colic if the cause of his complaint can be discovered by other means. Neither should it be possible for a greatly enlarged gall-bladder to be discovered accidentally, as is too often the case.

There are good scientific reasons for operating early in cases of gall-stones, quite apart from the clinical reasons—relief of pain and restoration of the patient

to a state of health. Gall-stones are the result of a chronic infection of the gall-bladder and its duct, the micro-organisms usually gaining access to the gall-bladder by means of the blood-supply, though it is possible that they may sometimes find their way directly from the intestine. The gall-stones are formed in the gall-bladder itself, and are only driven into the cystic and common bile-ducts by secondary processes. It must be assumed, therefore, that a gall-bladder which contains gall-stones is never in a healthy state. The inflammation leading to their formation is chronic, and their presence in the inflamed gall-bladder leads to still further changes, some of which are protective, whilst others are destructive in their character. The most common result of the long-continued irritation which they cause is a fibrosis. The gall-bladder becomes thickened and shrivelled (*Table A*, *Nos.* 21, 33) until it may be represented by a mass of fibrous tissue, in the centre of which is a gall-stone. In other cases, where a small gall-stone has blocked the cystic duct, the fundus of the gall-bladder atrophies so completely that it is impossible to find it at the time of the operation, and it is only recognized with difficulty when the liver has been removed at the post-mortem examination (*Table A*, *No.* 13). Sometimes the gall-bladder becomes dilated instead of shrivelling, and its walls may be so thin that it is a mere cyst full of calculi. Midway between these two extremes is the thick-walled gall-bladder (*Table A*, *No.* 16) which is so softened that it readily ruptures from an injury which would have had no effect upon a healthy organ. General suppurative peritonitis may follow upon such a rupture, and the patient may die as a direct consequence of a gall-stone of whose existence he was hardly aware. But it does not always require an injury to rupture a softened gall-bladder; suppuration is a common cause: the abscess bursts, and is either localized, or becomes the starting-point of a general peritonitis (*Table A*, *No.* 22). Sometimes the chronic inflammation ends acutely, and the gall-bladder undergoes necrosis either wholly or in parts (*Table A*, *No.* 37); whilst in other cases there has been ulceration involving the colon or duodenum (*Table A*, *No.* 26), cancer (*Table A*, *No.* 59), chronic inflammation of the pancreas (*Table A*, *No.* 53), impaction of a gall-stone in the intestine (*Table A*, *No.* 55), or the formation of dense adhesions (*Table A*, *No.* 23) leading to prolonged and difficult operations. Examples of all these conditions have come under my own observation, and the general conclusion at which I have arrived is that patients with a long history of painful and flatulent dyspepsia, raising a suspicion of the existence of gall-stones, require much more serious operations if they wait until acute symptoms compel them to seek surgical assistance, than those who are operated upon before such a critical stage is reached. The difficulties lie chiefly in the complexity of the adhesions, and in the impaction of gall-stones far away in the ducts. It is possible, too, that the continued irritation may lead to carcinoma of the gall-bladder, as it is thought to do in other parts of the body; my own experience is neither for nor against the theory as regards the gall-bladder. If, as is undoubtedly the case, the irritation produced by gall-stones leads to the various disastrous conditions here enumerated, there are good pathological reasons to insist upon an early operation in every case where a patient is thought to be suffering from cholelithiasis when it has been shown that other treatment is ineffective.

An examination of *Table B* shows that the risk attending operations in cases of uncomplicated gall-stones is extremely slight. I have been fortunate enough

to have had no deaths in twenty-six cases; whilst Prof. Kehr's statistics show that the average mortality in this class is only 3·6 per cent, for there were eighty-nine deaths in 2,494 operations. The mortality was much higher where the operation had been delayed until it was attended with even minor complications, for six of my patients died in a series of twenty-seven cases, the mortality being thus 28·5 per cent. It is noted in three of the cases that the patients were so extremely fat as to be bad subjects for operation. In the most serious cases the mortality was extremely high, reaching 55 per cent in my own cases, and 61·3 per cent in Prof. Kehr's series. It is interesting in this connection to observe how badly men bear gall-stone operation. In my own cases eight men recovered and nine died after operation; whilst forty-eight women recovered, and only eight died. Prof. Kehr's figures are; 526 men recovered and 123 died, an average of 23·4 per cent; whilst 2,494 women recovered and 275 died, giving a mortality of 11 per cent; the total average mortality for all cases of gall-stones operated upon being 12·9 per cent.

Final Results after Operation.—Mr. Edward Brunton, whilst acting as one of my dressers, has been successful in obtaining twenty-three replies to the fifty-six letters of enquiry he sent to patients who had recovered from operations for gall-stones. Those who know how difficult it is to trace hospital patients will appreciate the success of his efforts in this direction. Each patient was asked as to the condition of his general health, whether he had suffered any fresh attacks of pain since the operation, how long the wound had taken to close when the gall-bladder had been drained, and for any remarks he might choose to make. It was ascertained by these means that three of the twenty-three cases had died at varying periods after leaving the hospital from causes unconnected with the liver or gall-bladder. Fourteen of those living were reported as being in good health, without any return of their symptoms. Four complained that they still had attacks of pain from time to time. They said that it was not of a colicky character, but was rather of a dragging type, and it was, I suppose, due to adhesions. In no case was there any evidence of fresh gall-stones having been formed. When the gall-bladder had been drained and allowed to heal by granulation it is noteworthy that a permanent sinus had never been left, and each of the patients stated that the wound had closed within six or eight weeks after leaving the hospital. Two of the patients who had been operated upon for an abscess in the neighbourhood of the gall-bladder, and who were otherwise well, stated that they had a ventral hernia, for which a belt was worn.

CONCLUSIONS.

The results obtained from these tables show that gall-stones should be removed as soon as is convenient after they are known to exist, and when it is certain that nature, assisted by medicinal means, is not going to allow them to pass without pain or much discomfort. I even go so far as to doubt whether, under the present policy of waiting for the stones to be passed spontaneously, the sum of human suffering produced by gall-stones is materially less in the twentieth century than it was when Jean Louis Petit wrote about them more than a hundred and fifty years ago. There is plenty of evidence to show that every attack of

colic, and even the long-continued presence of stones in the gall-bladder without the production of acute symptoms, is detrimental to the gall-bladder and the bile-ducts. No one thinks now of waiting until repeated attacks of appendicitis have destroyed the appendix, or caused it to become adherent to the surrounding structures. When a stone is recognized in the kidney it is removed before a chronic pyelitis has been produced, and if it is in the bladder there is no object in waiting until a cystitis has been set up and there is a septic infection of the urinary tract. An early operation is undertaken in each of these cases, and often with such signal success that drainage is dispensed with, and union takes place by first intention. Earlier operation in cholelithiasis would eliminate most of the complications which increase the severity of surgical measures and heighten a mortality which is otherwise insignificant. Mucoceles, empyemata of the gall-bladder, adhesions, ulcerations, necrosis, and localized peritonitis would be abolished, or would become much less frequent. The gall-bladder could be sutured in many more cases than is possible at present, and the patient would be able to continue his life's work, or take her place again in society, without undergoing the purgatory of suffering through which the present contemplative method of treatment compels them to pass.

When an operation is decided upon for the removal of gall-stones at the present time, it is usually done at an earlier period in hospitals than in private practice. It is important that a hospital patient should not lose his work owing to chronic invalidism or repeated attacks of illness. He is willing, therefore, to submit himself to operation as soon as he recognizes that medicine is useless. The wealthier class nearly always postpone a visit to the surgeon until they have exhausted all other measures, and have undergone " cures " at the various health resorts at home and abroad. The more difficult cases, therefore, and those attended by the highest mortality, are more likely to occur in private than in hospital practice. There ought to be no such difference. Poor and rich should alike receive the same advice, and everyone should be told that the proper treatment for gall-stones is early removal.

The exact operation performed does not seem to make a material difference to the result obtained. In my earlier cases the gall-bladder was usually opened, drained, and allowed to heal by granulation. The " ideal " operation was performed occasionally; that is to say, the gall-bladder was incised, the gall-stones were removed, and the gall-bladder was sutured at once without any drainage. This method has always seemed to me to be attended with some degree of risk, because the complete closure of an unhealthy gall-bladder may fail to occur, however satisfactory the line of suture may appear at the time of the operation. When the abdomen is closed, the surgeon is left in ignorance of many serious post-operative complications, such as leakage from or hæmorrhage into the gall-bladder, which may need immediate treatment to be effective. I have, therefore, abandoned the " ideal " operation except in the very simplest cases, and even in those I employ it with a certain degree of reluctance. In the future, perhaps, when gall-stones are removed as soon as they are recognized, and in accordance with the canons of modern surgery, the " ideal " method will come into greater use. In looking through the notes of the operations, I find that for the last two or three years I have done more cholecystectomies than I did at first; that is to say, I have removed the fundus of the gall-bladder in most of the cases, ligaturing

the neck, disinfecting the stump, and afterwards burying it by bringing the peritoneum over it on the same lines as is usual in appendix operations. In nearly all these cases drainage has been employed for twenty-four hours, either by means of a tube or a piece of gauze. Gall-stones are not usually reproduced after removal. They are formed in the gall-bladder itself and not in the ducts. Comparative anatomy teaches us that the gall-bladder is a convenience rather than a ncessity. It is well, therefore, to reduce to a minimum the slight risk of recurrence of biliary calculi by removing the gall-bladder at the time the calculi are removed. Perhaps it is by this means that I have been so fortunate as to escape the necessity of performing many secondary operations; my table shows that this has only been done once in the series.

As I am dealing more especially with gall-stones in their surgical aspect, I am not concerned with their treatment by medical means, even if I were competent to speak upon the subject. It is sufficient, therefore, to state that when gall-stones have been removed, the patient should be told that his method of life must be altered lest they should be formed again. More fluid, more exercise, more careful regulation of the bowels, are the chief points to which attention should be directed, on the assumption that gall-stones are the result of a chronic infective process starting in the alimentary canal. Whilst the gall-stones are present, it is useless to attempt to dissolve or dispel them by such means, but when they have been removed much can be done to restore the biliary apparatus to a healthy condition by curing the chronic cholangitis which originally led to their formation.

Finally, I would sum up the results at which I have arrived in the following propositions:—

1. The removal of gall-stones is not attended by serious risk in uncomplicated cases.

2. The continued presence of gall-stones in the gall-bladder and bile-ducts leads to chronic inflammation of the neighbouring tissues and organs.

3. This chronic inflammation is the chief cause of the complications which increase the danger attending operations for the removal of gall-stones.

4. Early operation is the best method of avoiding complications.

5. Early operation demands early diagnosis. It is the duty, therefore, of the general practitioner to examine his cases of chronic dyspepsia with greater care, and not to wait until attacks of jaundice, biliary colic, or even more acute symptoms make an examination of the gall-bladder imperative. The earlier the diagnosis is made, the less will be the average mortality of the operation.

REFERENCES.

[1] *Mém. de l'Acad. Roy. de Chir.*, Ed. Paris, 1781, i, 255–310.
[2] *Medico-Chirurgical Transactions*, 1880, lxiii, 17.
[3] *Deuxième Congrès de la Société Internat. de Chir. Rapp*, Brux., 1908, ii, 422–425.
[4] *Amer. Jour. Med. Sci.*, 1905, i, 376.
[5] *Diseases of the Liver, Gall-Bladder, and Bile-Ducts*, 1912, 721.
[6] *The British Medical Journal*, 1912, i, 9.

A CASE OF PERINEO-SCROTAL DERMOID CYSTS.

By ALBERT CARLESS, London.

The nature and character of dermoid cysts are now so well known that unless there are special and peculiar features in a case, it is unnecessary to report them. In the present instance the condition is probably unique, and therefore worthy of publication.

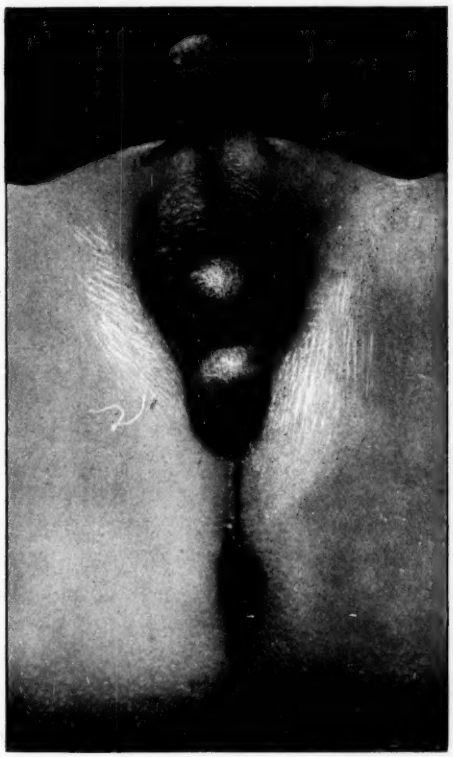


Fig. 8.—Perineal Dermoids, as they ordinarily appeared.

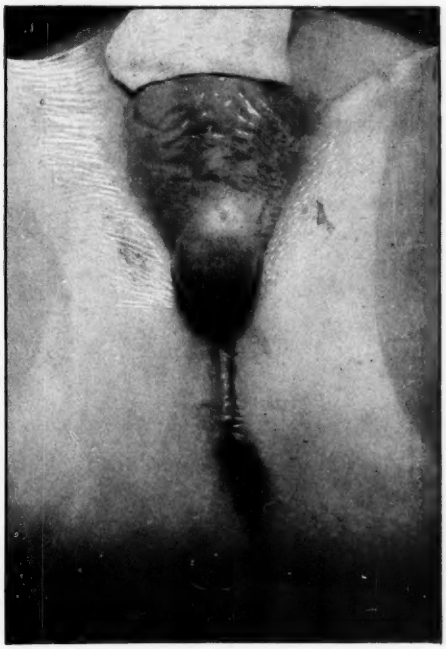


Fig. 9.—The anterior of the two cysts has been emptied by pressure into the posterior, which is much distended, as is also the perineal tube extending back to the anus.

The patient, a boy aged twelve or thirteen years, was sent to me by Dr. Dupont, of Twickenham, complaining of two swellings in the perineum, which caused no pain or inconvenience except by their situation; the condition had been present since birth and was increasing slightly in size. On examination, two swellings about the size of marbles were found (*Fig.* 8), one situated in the posterior part of the scrotum, and the other at the anterior extremity of the perineum; they were separated from each other by an interval less than an inch in length, and were subcutaneous; there was no attachment to the deeper

structures, and the skin, though tense, could be pinched up off them. There was an obvious communication between the two swellings, for one could be emptied into the other by pressure (*Fig.* 9) ; the sensation given to the fingers was that of thick fluid being expressed from one into the other cavity. The swellings were not translucent. Extending backwards from the posterior of the two swellings was a narrow median intradermic passage or track which reached as far as the anal margin ; this can be well seen in *Fig.* 8. It was obviously hollow, and could be emptied by running the finger from behind forwards, and then on pressure upon the posterior sac, a stream of the cyst contents could be seen rippling along the passage in the perineal raphe as far as the anal margin. Rectal examination demonstrated no abnormality. The testes were also normal, and had no communication with the swellings; the penis and urethra were normal and well formed. As the condition had existed since birth, and had only increased moderately in size, a diagnosis of perineal dermoids with extension backwards along the raphe was pronounced. The cysts and the narrow perineal canal were cleanly removed by dissection, and the case did perfectly well.

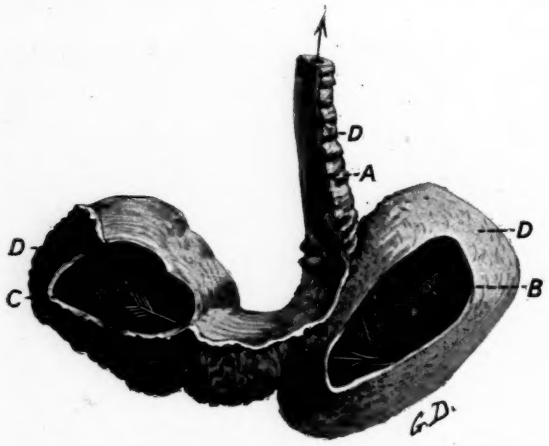


FIG. 10.—Specimen after removal. The posterior end of the perineal tube *A* has been cut away for microscopic examination. *B* and *C* are the two communicating cysts. *D* points to the skin.

The specimen was handed over to the Museum of the Royal College of Surgeons, and the accompanying drawing (*Fig.* 10) has been made of the specimen after hardening in formalin, and it has therefore become somewhat distorted.

A is the perineal tube, 30 mm. long with a lumen 2 mm. wide ; it was filled with epithelial débris and lined by dermal epithelium ; it lay in the perineal raphe, was quite superficial, and had a blind end posteriorly.

B. The posterior cyst was thin-walled, and measured 30 by 28 mm. ; it was distended with epithelial débris and lined by stratified epithelium flattened out by pressure.

C. The anterior cyst was about the same size, 30 by 25 mm., and was covered by the scrotal dartos, so that the skin was somewhat rugose.

The interest of the case lies mainly in the existence of the perineal tube, which throws some light on other conditions. In this connection one cannot but refer to a case published recently by Dr. Edington, of Glasgow.[1] In this instance a male child, two days old, came under observation for an imperforate condition of the anus, but the napkins were stained with meconium which escaped from an orifice at the back of the scrotum. The anal depression was shallow, and did not communicate with the bowel, but extending forward from it was "a nodulated ridge of some bulk" continuous with the perineal raphe. "The raphe from the anal depression forwards to the back of the scrotum was translucent

and of a blue colour, suggesting a tube containing meconium." Pressure from before backwards emptied the tube, which refilled from behind forwards on removing the pressure. In this case the raphe was excised. The communication with the bowel, which was very small, was laid open through the anal depression into the rectum, and the mucous membrane drawn down and sutured to the skin, with a good result. The canal in the raphe consisted of fibrous tissue lined with stratified epithelium.

Cases more or less similar in nature to Dr. Edington's have been frequently described, in which an imperforate condition of the anus has co-existed with an abnormal opening located in the female at the posterior end of the vulval orifice, and in the male at the back of the scrotum or on the under surface of the urethra. Openings into the bladder have also been known, but these latter are probably of a different nature and due to a partial persistence of the cloacal condition. In Dr. Edington's case, the abnormal passage was subcutaneous, and evidently not due to an abnormality of the cloaca.

My own case throws light on conditions such as this. It was obviously due to an error of development connected with the external genital folds. It will be remembered that about the second month of intra-uterine life, the genital eminence appears at the junction of the ventral surface with the posterior extremity of the body. From this is developed the penis in the male and the clitoris in the female. It is surrounded by an oval fold of skin, the genital fold which extends backwards on either side of the hind end of the spine, and thereby constitutes a shallow fossa at the bottom of which is the cloacal membrane. The posterior part of this fossa is separated from the anterior at a later date by the ingrowth on either side of a perineal fold. In the male, the groove or fossa in front of this disappears entirely, and the scrotum takes its place ; in the female it remains as the vulva. The non-union of the two segments in the male gives rise to the cleft scrotum occasionally seen in conjunction with hypospadias ; a partial obliteration could perfectly well determine the conditions described above. In my own case the obliteration was complete except for a tiny track behind, and a larger bilocular cavity in front which constituted the dermoid cysts ; in Dr. Edington's case a narrow passage persisted, extending back from the scrotum, and associated at that spot with an abnormal opening into the bowel.

REFERENCE.

[1] *Brit. Med. Jour.* 1912, ii, 1373.

THE TECHNIQUE OF BUTLIN'S OPERATION OF MARGINAL RESECTION OF THE TONGUE.

By SAMPSON HANDLEY, London.

The object of the present short paper is to draw attention to a method originated by the late Sir H. T. Butlin, of treating by operation cases—(*a*) Where the tongue is originally, or has become, too large for the mouth; (*b*) Where its lateral margin in contact with the teeth shows dangerous or annoying irritability.

The effects of the operation are: (1) The size of the tongue is reduced without altering its shape, impairing its mobility, or interfering with speech; (2) The teeth, instead of being in contact with an irritable papilla-bearing surface, now lie in contact with smooth mucous membrane derived from the inframarginal surface of the tongue. Moreover, owing to the reduced size of the tongue, the contact between it and the teeth is less intimate.

The operation is not of recent origin. It was practised by Sir H. T. Butlin for a number of years. I believe, however, that it is less widely known than its merits deserve, perhaps because its author preferred to exercise the scalpel more often than the pen. Indeed, he had not troubled to christen his offspring, for which I venture to suggest the name "marginal resection of the tongue."

The notes of the case which drew my attention to this method are as follows:

Case 1.—Miss A. G., aged 36, was sent to me in February, 1911, by her medical man on account of the condition of her tongue, a condition which had been present since childhood, but was only definitely noticed by the patient at the age of seventeen. It gave her no trouble until 1907. At that time she began to have attacks of soreness in it, lasting perhaps a week, and recurring every three or four months. These attacks have increased in frequency and severity, and the tongue is now a source of constant discomfort to her. Her teeth are in good condition and do not appear to be causing irritation. The only noticeable fact in the history is that for twelve years past she has been subject to attacks of abdominal pain, unrelated to food, associated with vomiting, lasting perhaps half an hour and occurring at irregular intervals. For the last four years these attacks have been almost in abeyance. The bowels are habitually somewhat loose. There is no evidence of syphilis.

On examination, the tongue is obviously too large for the mouth, and is deeply marked by the teeth. The dorsum of the tongue is covered by closely-set foliated papillary eminences, separated by deep grooves and indentations, and this condition is most marked towards the margin. The whole tongue is sore, more especially at its edges, but is not ulcerated. She finds that vaseline temporarily relieves the soreness. Rough or pungent articles of diet, such as curry or toast, do not seem to aggravate the condition, nor does singing, which she practises constantly.

Believing that the condition was one of papillary hypertrophy, probably depending on congenital lymphatic obstruction, I told her that, in my opinion, some form of plastic operation to reduce the size of the tongue would be advisable, especially since various applications had failed, and since her pleasure in life was seriously interfered with.

I thought of resecting a wedge from the tip of the tongue and taking out lateral wedges from the margins opposite the molar teeth; but before doing anything I asked the patient to consult Sir H. T. Butlin and obtain his advice. He counselled the operation of marginal resection in the following letter:—

"*March* 28, 1911.

"Many thanks for your note with Miss G——. I cannot cure her any more than you could. Nor do I know what that condition is due to. I have seen several cases precisely similar, but I have never been able to work out their history or how they arose. I scarcely think they can be due to congenital defect, because there is an absence of papillæ in the fissures, and papillæ occur right down to the bottom of true physiological fissures. Also, she never noticed the fissures till she was about seventeen, when she appears to have found them. Again, they associate with some enlargement of the end of the tongue, so that it becomes indented by the teeth, and sore from rubbing. There is more induration of that part of the tongue than there is in the plicated tongues.

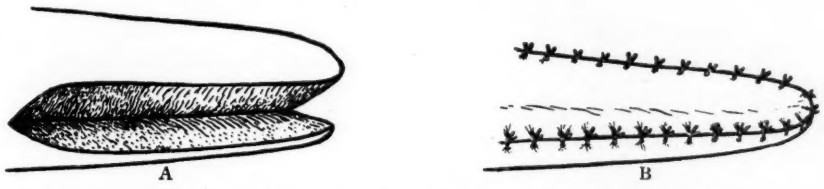


FIG. 11,—MARGINAL RESECTION OF THE TONGUE.
Butlin's original diagram of the operation. (Burghard's *System of Operative Surgery*.)

"It has been suggested that this condition depends on previous circulus migrans of the tongue (the pathology of which has not been discovered). But I have not been able to trace any connection. There is the possibility of S.—contracted, not hereditary, because there are no signs of H.S.—but contracted from a nurse or some other person in infancy. But there are no gummata, and no actual ulcers.

"I have given Miss G—— toilet lanolin instead of vaseline, but I have told her that she had better ask you (when she has tried the lanolin for a little while) to trim the tongue and remould it for her. If you have not done it, you will find the description and figures in my article in Burghard's recent book. If you do a preliminary laryngotomy (not tracheotomy), you can operate at your leisure and with practically no danger to the patient."

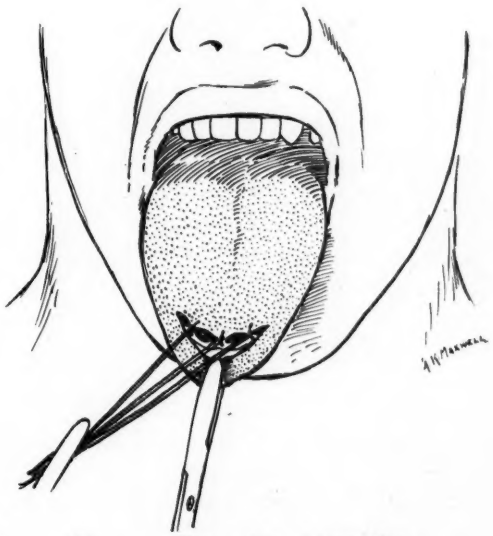


FIG. 12.—First stage of operation.

The operation was performed by a somewhat modified technique which I devised to prevent hæmorrhage and to avoid recourse to laryngotomy.

One object of the present paper is to state this technique precisely, since in my opinion it makes the operation much simpler and safer. *Figs.* 12 to 15 will help to make the explanation clear.

The patient being anæsthetized, the tongue is transfixed far back by a stout

silk ligature which serves to control it. The excision of the wedge is commenced at the tip of the tongue, and involves at first two converging incisions about an inch and a half in length (*Fig.* 12). Before anything further is done, sutures are introduced. The effect is that bleeding is stopped, and the tongue can now be

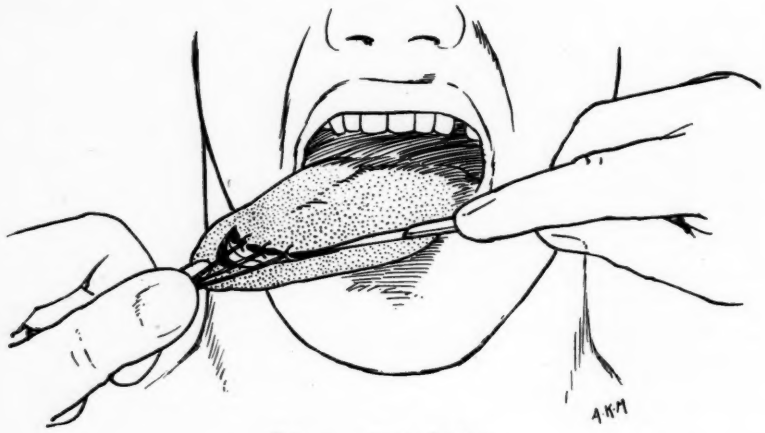


FIG. 13.—Second stage.

manipulated by a loop of tissue, shortly to be removed, but still attached at both ends like the handle of a hand-bag. Making traction on this handle, a further portion of the marginal wedge, perhaps an inch long, is now cut along the margin of the tongue, and again stitches are introduced. The same

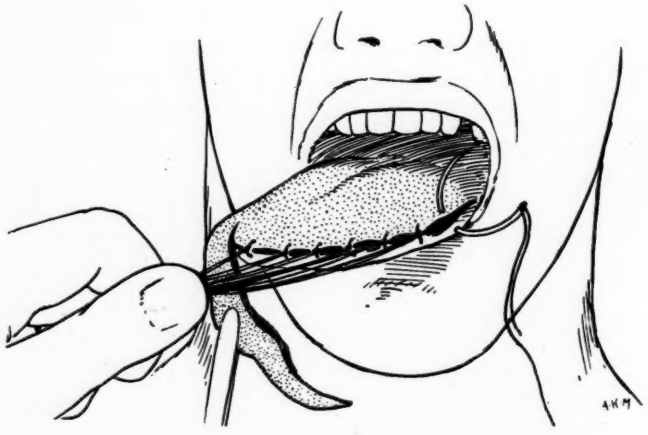


FIG. 14.—Third stage.

manœuvre is carried out on the opposite side of the tongue, and is repeated until the wedge has been cut and the sutures have been placed right back to the last molar tooth. When this point has been reached, the V-shaped notch cut in the tongue is made more and more shallow, until the posterior end of the wedge is freed entirely on either side, and comes away. Operating in this way, hæmorrhage

is reduced to a minimum. The tongue is easily controlled throughout, and laryngotomy becomes unnecessary.

In excising the wedge, the lower of the two incisions accurately follows the junction between the rough mucosa of the dorsum and the smooth mucosa of the inframarginal portion of the tongue. Thus none of the latter is sacrificed, and the strip of mucosa removed is derived entirely from the dorsum. The teeth now lie in contact with smooth inframarginal mucosa, and do not touch the papilla-bearing portion of the tongue.

FIG. 15.—The operation completed.

The skilful administration of the anæsthetic is a very important point in the operation, for the patient's coughing reflex should not be abolished. In this respect I am much indebted to Dr. C. V. Martin, anæsthetist to the Bolingbroke Hospital, who administered the anæsthetic in *Case* 1.

The incision in the tongue rapidly healed, the stitches were removed on the fifth day, and the patient left the hospital on the eighth day feeling quite comfortable. She was seen again in June, 1911. The tongue was of normal size, scarcely marked by the teeth, and the papillary condition of the dorsum had certainly subsided. The soreness had completely disappeared, and the only thing of which she complained was an occasional twinge of sharp pain in the tongue. As a rule she is entirely oblivious of the existence of the tongue, and she is delighted with the result. The scar of the resection can only be seen with difficulty. The patient states that she has lost a lisp which characterized her speech, but a trace of this still remains.

FIG. 16.—*Case* 1. The strip of tongue removed (natural size).

This patient was again seen recently (Jan., 1913) and her tongue was photographed (*Fig.* 17). She still remains perfectly comfortable. A microscopic section of the portion of tongue removed failed to throw light on the cause of the papillary and general hypertrophy.

Opportunities for the practice of marginal resection are few, for its possibilities are not generally known, but in a second case, recently, I have again performed the operation with most satisfactory results. In this instance only a unilateral operation was required.

Case 2.—Miss E. B., a lady of middle age, was sent to me on January 2, 1913, by Dr. J. B. Mason, of Ealing. Four years ago she first noticed that her tongue was very sore on the left side, and a little white mark appeared along the left margin. The soreness grew progressively worse, and about May, 1910, she first sought medical advice. Since that time she has had varied treatments, without lasting benefit. In May, 1910, she saw a lady physician, who applied picric acid to the affected area, and prescribed injections of a non-autogenic vaccine and a tonic containing arsenic. Later in 1910, she saw a well-known lady surgeon, who considered that the condition might be a nævus and advised the use of electrolysis. At other times *x*-rays were administered to the tongue, and in 1912 zinc ionization was given with some benefit by Dr. Mason. In June, 1912, she saw another surgeon, who at first considered the condition might be tuberculous. He painted it once with a strong acid, the nature of which the patient did not know. In July, 1912, another physician painted the area with 30 per cent chromic acid, once a day for a time, and then two or three times a week with the same acid in 40 per cent strength. Altogether this treatment lasted for a month without any improvement taking place. In September, 1912, a mixture of salvarsan and glycerin was prescribed by Dr. Mason to be rubbed on the tongue, and this treatment produced temporary relief. In October, 1912, a surgeon suggested and carried out the application of the actual cautery. The cauterized area healed up after five weeks and the tongue looked better, but there was no subjective improvement. Orthoform was at one time applied to the tongue, and the patient once took iodide for a long time without benefit. The teeth have also received careful attention. The patient formerly wore an upper plate, but has not done so for eighteen months. The persistence with which the patient has tried various treatments seems to prove conclusively that the soreness had been severe, and a source of chronic misery.

FIG. 17.—*Case* 1. The tongue about a year after operation. Note the papillary hypertrophy, with deep sulci, mostly transverse.

On examination of the tongue I found on the left side a whitish area, devoid of papillæ, extending from near the tip to the foremost circumvallate papilla, its lower edge corresponding to the margin of the tongue, while its upper edge showed a fairly sharply-marked line situated on the dorsum. At its widest part the area measured about an inch from side to side. On the right side of the tongue, although here the patient complained of no soreness, a similar but smaller bare area was found.

Since the futility of local applications had been conclusively proved, I advised unilateral marginal resection on the left side. This was done at Ealing, with Dr. Mason's assistance, about January 10, 1913, Mr. Apperly giving the anæsthetic. The technique used was that already described in this paper, and practically no blood obtained access to the pharynx. The stitches were removed about the sixth day.

At the beginning of February, Dr. Mason reported to me that the patient had entirely lost the soreness of which she complained, that her articulation remained good, and that the tongue was soundly healed. There had been no

return of symptoms up to the present, though the patient complains of an occasional twinge in the region of the scar. She says she feels that her tongue " inhabits a palace," a phrase which expresses very well the sensation of space, and freedom resulting from the diminution in the size of the tongue and the absence of irritating contact between the excised tender area and the left alveolar margin. I saw this patient recently and was well satisfied with the result. The scar can only be seen with difficulty.

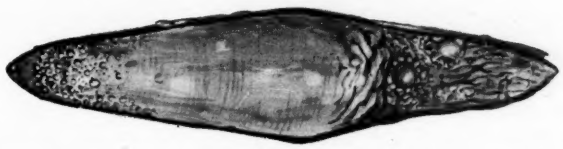


FIG. 18.—The strip of tongue removed in *Case* 2 (unilateral marginal resection). Note the circumvallate papilla visible near the posterior end of the strip.

It appears likely that marginal resection may find its widest field of service in selected cases of chronic glossitis of syphilitic origin. It removes that particular area of the tongue which is known to be the seat of election for carcinoma, and moreover, by reducing its size, it removes the tongue from contact with the teeth. Butlin considered that the operation of marginal resection is specially appropriate to syphilitic cases. I may here quote his remarks upon this subject :

For many years past I have operated on cases of chronic superficial affections of the tongue which have resisted treatment, and in which ulcers, fissures, and tender areas have formed again and again, or where thick and threatening areas of leucoplakia have formed. Experience of the earlier cases has enabled me to hold out much more definite promise of success than I could do in the first cases of the kind. But operation is not applicable to all cases. Some of them are so extensive that they would necessitate removal of a large part of the tongue, of the floor of the mouth, of the gums, and of the inside of the cheeks. So far as the tongue is concerned, the most favourable cases are those in which the disease is limited to the dorsum, or to the borders and tip. The cases are better suited to operation if the under surface of the tongue is not affected, as the mucous membrane can then be employed in the remoulding of the tongue.

A prejudice exists against operations on persons whose tongues exhibit signs of past or recurring syphilis, lest the wound should refuse to heal and become syphilitic. I have many times operated on such tongues. Provided the incisions be carried through the unaffected portions of the tongue, the patients seem to recover as well as any other patients, and none of the wounds have become syphilitic ulcers. Even in those cases in which the incisions have been carried through parts which have been the seat of past syphilitic lesions, I have seen no mischief, provided the disease be not progressive and the parts be soundly healed. The prejudice against operations on such tongues does not therefore seem to be justified.

In those cases in which the borders only are affected, incisions are carried round the tip and borders so as to enclose the whole area of the disease and to meet at their posterior ends on each side. They are carried well into the substance of the tongue, so as to enclose a wedge-shaped piece of muscle. The edges are approximated. These operations are very successful. The removal of the borders and tip in the manner which has just been described results merely in diminishing the size of the fore-part of the tongue, and does not interfere with speech. It is very desirable, in such cases, not to leave a projection at the point on each border where the incisions meet, since such projections are apt to be irritated or even caught between the teeth and bitten.[1]

I have written this brief paper as a tribute of respect, and because I believe the operation of marginal resection is little known. Performed by the technique I have suggested, it is practically free from the risk of hæmorrhage and its attendant lung complications. Its more general employment would doubtless diminish appreciably the frequency of tongue-cancer.

I am sure the readers of this journal will feel indebted to me for reproducing the letter given on p. 43. Written in haste and in a period of declining health, it reveals the writer perhaps the more clearly for its lack of literary pretension. Up to his latest days Butlin lived on the edge of knowledge, seeking truth there in the surrounding darkness, ready always to assist another's search. Above all, he never permitted ignorance, whether in himself or others, to masquerade as knowledge, and he always stated the facts in few and plain words.

REFERENCE.

[1] BURGHARD'S *System of Operative Surgery*, ii, 209.

AUTOPLASTIC GRAFT OF FIBULA INTO HUMERUS AFTER RESECTION FOR CHONDRO-SARCOMA, WITH OBSERVATIONS ON BONE-GRAFTING.

By G. E. GASK, London.

Grafting of bone is no new thing, for more than twenty-five years ago Poncet,[1] after resection of the diaphysis of a tibia for infective osteomyelitis, implanted, with satisfactory results, fragments of bone taken from a new-born child dead of asphyxia, and from a recently-killed kid. Of late years the subject has been receiving much attention, and it has been demonstrated clearly that bone may be grafted successfully and that application of the method may be the means of preserving bones and limbs which previously would have been sacrificed.

The possibility of grafting skin has been known for years, but it is only lately that attempts have been made to transplant other organs and tissues. Now there is abundant proof that the method may be applied to fascia,[2] bones, tendons, vessels, and portions of other organs such as the thyroid gland, kidney, and ovaries.[3, 4, 5]

Fig. 19.—Skiagram of the Humerus before Operation.

Much attention has been paid to the relationship of the donor of the graft and the recipient; the general conclusions of the different investigators being that autoplasty is most satisfactory, that homoplasty between near relations is the next best, and that heteroplasty is of very little service. There are, however, one or two cases reported in which the bone of an animal has been implanted into man and has survived. It is perhaps open to doubt whether these grafts actually produced new bone or merely acted as a framework for deposition.

The following account is illustrative of an autoplastic graft:—

History. — In September, 1911, a boy, aged 11, was admitted to St. Bartholomew's Hospital on account of a painless swelling in the upper part of the left arm, which had been noticed twelve months previously. There was no history of injury.

Anatomy.—Size of the swelling by external measurements—2½ by 1½ inches. Situation—shaft of the left humerus a little above the centre of the bone. The muscles of the left arm were smaller than the right, probably the result of disuse

atrophy. There were enlarged glands in the left axilla, which could be accounted for by a sore place on the left elbow. The boy had a congenital cataract, but in all other respects was normal. A skiagram (*Fig.* 19) showed a swelling expanding the bone, and a provisional diagnosis was made of endosteal sarcoma.

Operation (Sept. 28, 1911).—The humerus was exposed by a longitudinal incision on the outer side of the arm. The compact bone was so much destroyed that it could be cut into easily with an ordinary scalpel, and a piece was cut out for immediate microscopic examination. The report of the section was that it consisted entirely of hyaline cartilage. As there was no appearance of a capsule it was decided to remove the tumour entirely and not to scrape it out, especially as it seemed that such a procedure would weaken the bone in a dangerous manner.

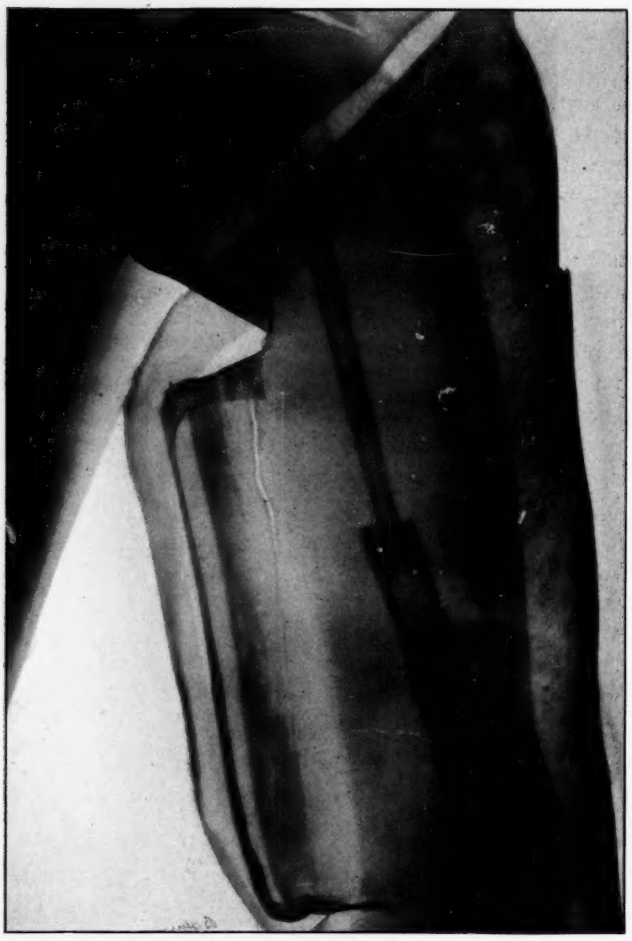


FIG. 20.—SKIAGRAM TAKEN IMMEDIATELY AFTER OPERATION. The bones are somewhat obscured by the poroplastic splint.

The humerus was sawn through transversely half an inch above and below the tumour, and three inches of the bone removed with its periosteum. The left fibula was then exposed, and three and a half inches of the shaft removed with the periosteum complete. All muscular and tendinous attachments were dissected off carefully, and the graft placed in normal saline at a temperature of 104° F., while its bed was being prepared in the humerus. The medullary cavity in each free end of the humerus was now hollowed out with a burr for a distance of half an inch, and then the fibula jammed in the cavity. The muscles were stitched round the bone with catgut, the skin was closed, and a poroplastic splint applied. Primary union took place (*Fig.* 20). Macroscopic examination showed that the humerus contained a solid growth resembling cartilage which occupied the medullary cavity and penetrated to the surface at the side. It had no definite capsule, but was surrounded by somewhat

sclerosed bone. Microscopic examination showed that the tumour consisted of hyaline cartilage. The diagnosis of chondro-sarcoma was based on the fact that the tumour was infiltrating, and on the knowledge that such swellings are often recurrent.

Subsequent Course.—The accompanying skiagrams show the later changes. A few weeks later a small amount of growth could be seen from the two ends

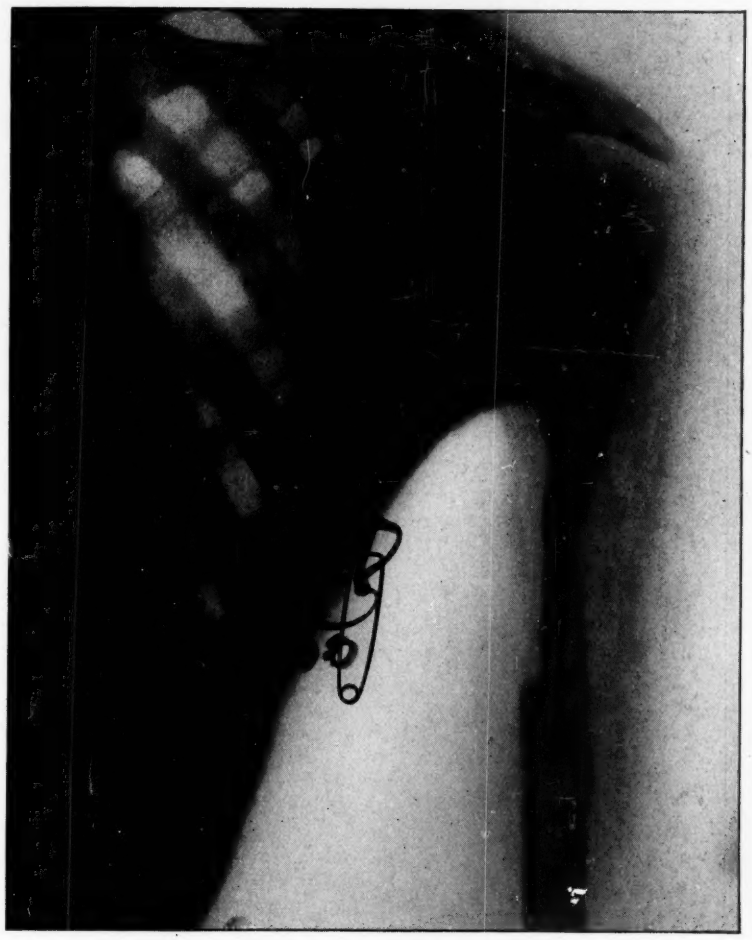


FIG. 21.—SKIAGRAM TAKEN THREE MONTHS AFTER OPERATION.
New bone can be seen extending along the whole length of the graft, which is now fixed at both ends.

of the humerus, while the graft appeared to remain stationary. Then a faint line of growth was seen along the whole length of the implanted fibula, suggesting development from the periosteum (*Fig.* 21). From that time growth was rapid; good union had taken place between the fragments by the end of December, 1911, that is, three months after the operation, and in another three months (*Fig.* 22) the skiagram shows that the bone had united solidly and has

increased in thickness. From an early date the boy was encouraged to use his hand and arm in the splint, so that the nutrition of the limb should be maintained.

At the time of writing, seventeen months after the operation, the boy has an arm which to all intents is as good as the other. He goes to school and joins in the ordinary games. The movements are perfect, and he has no sort of pain.

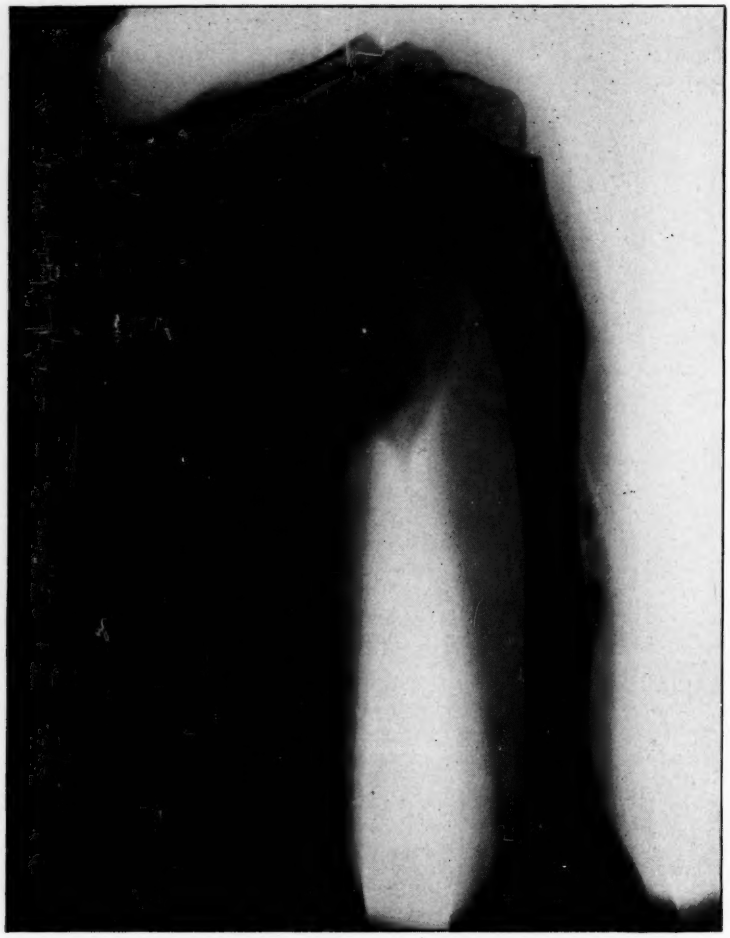


FIG. 22.—SKIAGRAM TAKEN SIX MONTHS AFTER OPERATION.
Much new bone has been deposited, the outline of the fibula being only just visible at the upper end. The bowing is due to the fact that the upper end of the graft slipped out of the humerus. The greater part of the new bone has been deposited on the concave side.

Measurements show that the left humerus is three-eighths of an inch shorter than the right, and the circumference of the limb is a quarter of an inch less. The loss of the fibula is not appreciable; he can walk just as well as ever, and is not weak on that side; in fact, unless told, one would not know that a piece of the fibula had been removed (*Fig.* 23).

Fig. 24 shows that much new bone has been formed, and it looks as if communication is being established between the medullary cavities of the graft and the humerus.

Observations on the Technique :—

1. The portion of humerus was removed, together with its periosteum, and the graft of fibula was inserted with its periosteum intact.

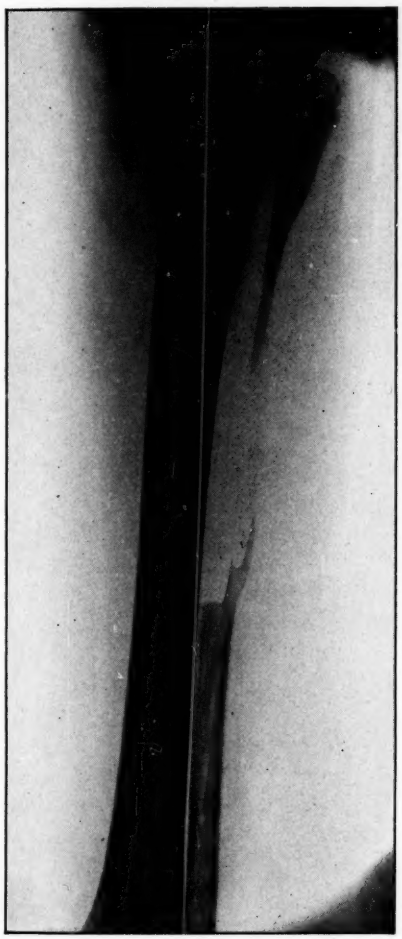


FIG. 23.—SKIAGRAM TAKEN THREE MONTHS AFTER OPERATION.
This shows the gap left after removal of the piece of fibula, and new bone being formed from the two ends.

FIG. 24.—SKIAGRAM TAKEN SEVENTEEN AND A HALF MONTHS AFTER OPERATION.
The graft is now part of the humerus : there is indication that the medullary cavities are communicating. The bowing previously noted persists.

2. No holes were drilled into the graft with the idea some surgeons have of allowing access of blood to the bone—it would appear that this is unnecessary.

3. All muscular and tendinous attachments to the fibula were dissected off with scrupulous care. It seems desirable that this should be done, seeing that such fragments would inevitably perish and might prejudice healing.

4. The bones were not secured in position by any foreign body, such as a screw, peg, or plate; this has its advantages and disadvantages. In the above case the upper end of the graft slipped out of the socket in the humerus, and this accident accounts for the bowing of the bone as seen in the skiagram. Cases are reported in which screws have been used with success, and probably some such device would be of great assistance.

CONCLUSIONS.

1. An autograft of bone taken under favourable conditions (youth of the individual is a favourable factor) will live and grow. It will certainly grow in thickness, though whether it will grow in length, and at the same pace as the corresponding bone of the opposite arm, remains to be proved.

2. The periosteum of the graft is of service to the bone, whether as a limiting membrane only, or as an active factor in the deposition of new bone.

3. There is evidence to show that bone without its periosteum will grow, and that even the marrow alone will survive and deposit new bone, but until we know more it is better, when possible, to employ bone with its periosteum.

4. Transplantation of bone from an animal to man and the use of bone from dead bodies is merely in the experimental stage, and for the present sufficient material may be obtained from the tibia, fibula, and ribs.

REFERENCES.

[1] PONCET, *Rev. de Chir.*, xliv.
[2] DAVIS, *Johns Hop. Hosp. Bull.*, 1911.
[3] TUFFIER, *Rev. de Chir.*, xliv.
[4] LEXER, *Archiv. klin. Chir.*, xcv., pt. 4.
[5] MACEWEN, The Growth of Bone.

A CONSIDERATION OF THE INFLUENCE OF THE FIRST COSTAL CARTILAGE ON APICAL TUBERCULOSIS, BASED ON A STUDY OF 402 SPECIMENS.*

By H. MORRISTON DAVIES, London.

The invention of a new method of attack upon a problem which has resisted many generations of investigators is always a particularly interesting and valuable contribution to science. Even if the direct success of the new method is but meagre, the indirect value it has in stimulating research upon fresh lines may be very great. Unfortunately, however, the freshness of an original idea does not necessarily render it acceptable, but may lead to its being crushed by authoritative opinion as unworthy of consideration, or left to a localized group of supporters whose very enthusiasm is regarded by general opinion as being a further argument against the validity of the conception.

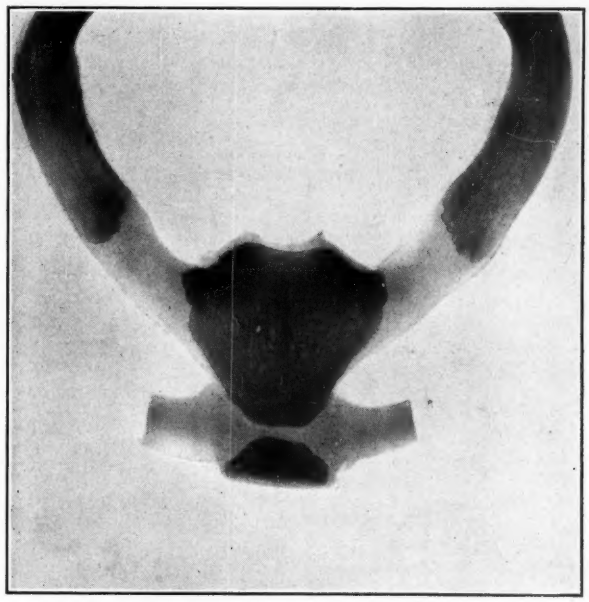


Fig. 25.—Male, aged 17. First costal cartilages normal. Movements at sternal angle 6°. Old and recent tuberculous lesions at the apices of both lungs.

The suggestion originally propounded by Freund, of the close relationship and interdependence of abnormal changes in the first costal cartilage with apical pulmonary tuberculosis, has received both these methods of treatment. In 1858 and 1859, when Freund first enunciated his view, outside a small circle, practically no serious notice was taken of it, and during the next forty years very few contributions appeared upon the subject. The suggestion of the relationship of abnormal changes in the first rib cartilage and apical tubercle was then revived, and contributions ranging from short papers to lengthy monographs—mostly in German—began to appear, all affirming with almost equal enthusiasm the soundness of the hypothesis.

* From the Research Laboratories, University College Hospital Medical School. The expenses of this research have been in part defrayed by a grant from the British Medical Association.

In 1858 and 1859, attention was first drawn by Freund to two types of abnormality in the chest wall, both of them affecting the costal cartilages of the ribs, and both directly predisposing to the development of secondary pulmonary lesions.

Both types produce their effects by causing fixation of the affected part of the thorax. In the one, ossification attacks the second, third, fourth, and fifth rib cartilages, and produces a fixation of the chest in the expanded position, with separation of the ribs, forward displacement of the sternum, and increase in the costal angle; this is the condition known as rigid dilated thorax (starr dilatierte Thorax), with which bronchitis and emphysema are invariably associated as a secondary phenomenon. In the second type of abnormality the first costal cartilage alone is affected, being either ossified or abnormally short, and the fixation of the upper part of the chest which results is regarded as very strongly predisposing to apical tuberculosis. It has been shown that the ossified cartilage may fracture and a false joint develop between the fractured surfaces, and Freund has further elaborated his hypothesis to include the view that the restoration of movement to the upper thoracic opening by the false joint leads to the healing of the tubercle in the apex of the lung.

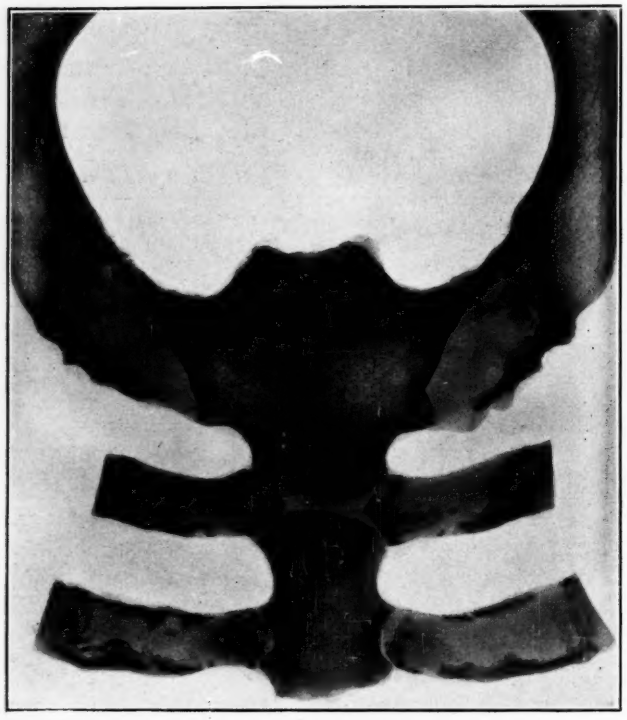


FIG. 26.—Male, aged 50. First costal cartilages show slight ossification. Note changes in second and third cartilages. Movement at sternal angle 7°. Lungs, right apex normal: left shows healed apical tuberculous lesions.

Rigid Dilated Thorax.—The co-existence of the characteristic picture of the rigid dilated thorax with the pulmonary lesion of bronchitis and emphysema was easily determined, while the results of the operation of removing the affected cartilages, as seen in the cases shown at the Congress of the *Deutsche Gesellschaft für Chirurgie*, in Berlin, in 1910, were sufficiently encouraging to satisfy me that the operation was not only theoretically sound, but also practically efficient in greatly alleviating the distress of people suffering from this disease. The results which I have obtained from operating on patients so afflicted have served to strengthen this view. The further consideration of this group of cases is not within the scope of this paper.

The First Rib Cartilage.—Freund, holding the view that when tubercle had attacked the apex of the lung as a result of abnormal rigidity of the first rib cartilage, the tuberculous foci often healed if fracture of the cartilage occurred spontaneously, suggested that division of the affected cartilage should be undertaken for cases of active apical tuberculosis.

This operation seemed to me to be a rational procedure provided the premises were correct; but the evidence in support of these premises did not appear to me to be unexceptionable, and to satisfy myself, therefore, I undertook the investigation of the relationship of apical tuberculosis and abnormalities of the first costal cartilages.

This paper is not intended to be a critical review of the work of Freund, Hart and Harras, Rothschild, and others, who have studied the alterations in size, shape, and character of the ribs, cartilages, manubrium, and manubriosternal joint which contribute to the movement and form of the upper thoracic opening, but rather to give the results of my own observations.

The material on which my investigations were made consisted of:—

1. *Specimens from* 201 *autopsies.*

2. *One hundred radiograms.*

3. *The thoracic skeleton and contents from seventeen monkeys.*

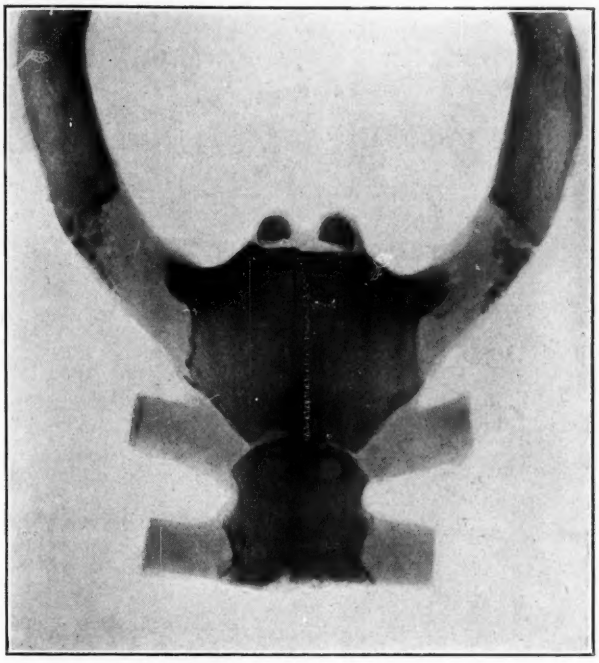


FIG. 27.—Male, aged 32. First costal cartilages show slight ossification. Movement at sternal angle 1°. Large tuberculous cavities at the apices of both lungs.

1. **Specimens from 201 Autopsies.**—These consisted in the majority of cases of the manubrium sterni and upper part of the gladiolus, the first rib and costal cartilage, and the cartilages and adjacent parts of the second and third ribs, removed in one piece; in a certain number of the cases the gladiolus and first ribs and cartilages only were obtained. In every case the lungs were also reserved for examination. The skeletal portions were dissected clean of all soft parts, measurements were taken of the maximum breadth of the upper thoracic opening, as determined by the greatest width between the inner (and upper) borders of the first ribs, while the proportionate width of either side was obtained by laying the specimen so that the centre of the gladiolus and the centre of the suprasternal notch both rested on a straight line which was continued beyond them; measurements were then taken from this mesial line to the inner border of the first ribs at their maximum breadths. The sternal angle and the degree

of movement in it were noted. In some cases a radiogram was taken of the specimen. The whole specimen was next divided with a fret saw into an anterior and posterior segment. The cut surfaces allowed of accurate observation and measurement of the cartilages. The length of each cartilage was obtained by measuring from the mid-point (between the upper and lower borders) of the costo-chondral junction to the mid-point of the chondro-sternal junction. To study more fully the degree of ossification and the state of joint formation or fracture, antero-posterior vertical and horizontal sections were made through the cartilages. To record the degree of ossification of the cartilages, the terms "normal," "slight ossification," and "marked ossification," have been employed. The separation into the last two groups must necessarily be an artificial one, and based on one's individual standard. If ossification extended over both upper and lower borders and over the anterior surface (as in *Figs.* 28–30), the condition was called one of "marked ossification;" if, however, the ossification was in patches and limited (as in *Figs.* 26 and 27), the cartilages were described as showing "slight ossification." In a research such as this, when one recognizes that the separation of the description of the cartilages into groups labelled "slight" and "marked" ossification is to a certain extent an arbitrary one, and when one further realizes the insecurity of the decision whether an old healed scar at the apex of the lung is a tuberculous lesion or not, it is obvious that precautions must be taken to eliminate fallacy as far as possible from the judgment on each item of the material. For this reason the following routine in the examination of the specimens was adopted. The skeletal part was completely examined and recorded by me, while the condition of the lung, the presence or absence of old and healed or recent and active tubercle, was noted and recorded independently by Dr. Theile or Mr. Embleton, except in the case of the twenty-seven specimens from the City of London Hospital; this series was very kindly obtained for me by Dr. Gloyne, by whom the condition of the lung was recorded.

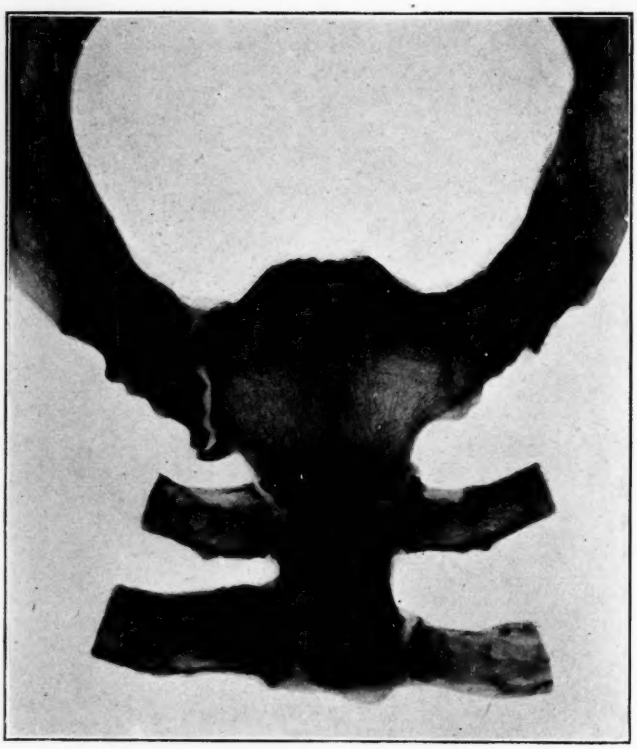


FIG. 28.—Male, aged 72. Marked ossification of both first costal cartilages. Right side, false joint at the costo-sternal juncture. Left side, false joint in middle of cartilage. No movement at sternal angle. The apices of both lungs normal.

To Dr. Theile and Mr. Embleton, and to Dr. Gloyne, I tender my best thanks for the very great assistance they have been to me.

The range of movement at the angle of Ludovici was estimated by a goniometer. After the specimen had been divided into anterior and posterior portions, the condition of the union between manubrium and gladiolus and the presence or absence of a cavity in the fibro-cartilage, or of ossification, were noted.

The 201 specimens were obtained as follows :—

One hundred and twenty-seven were from autopsies at University College Hospital, on patients of ages ranging from twelve to eighty-two years. These were in no way selected.

Twenty-seven were from autopsies at the City of London Hospital for Diseases of the Chest, on patients from twelve to seventy-three years of age.

Twenty-two were from Infirmaries, and were selected cases inasmuch as they were consecutive cases of adults dead from pulmonary tuberculosis ; making a total of 176 specimens from males and females of over twelve years, and giving, therefore, for comparison and study, 352 first costal cartilages and a similar number of lungs.

The remaining twenty-five specimens were from a consecutive series of autopsies at University College Hospital, from children under twelve years of age.

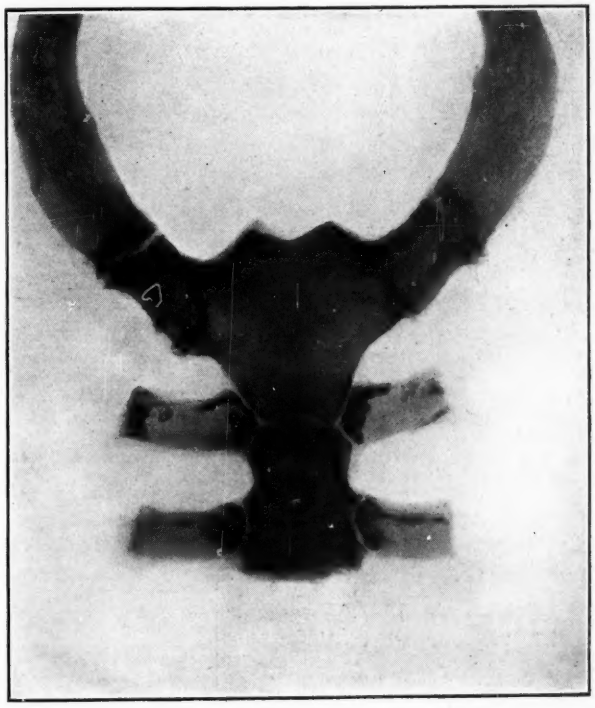


FIG. 29.—Female, aged 55. Marked ossification of both first costal cartilages. On either side false joint close to costo-chondral juncture. On right side healed fracture at costo-sternal juncture. No movement at the sternal angle. The apices of both lungs normal.

2. **The Radiograms.**—In order to obtain further data on the relationship of the ossification of the first costal cartilage to age and sex, 100 consecutive radiograms of the upper part of the chest (all of which had been taken for quite other purposes) were examined, the condition of the cartilages recorded, and the age and sex of the patient. The proportion of females in this series is smaller than I should wish, but in order to avoid selection the series was in no way altered.

3. **The Thorax and Contents of Seventeen Monkeys.**—I obtained from the Zoological Gardens the thorax of seventeen primates, of ages varying from about one to six years, in order to see whether ossification or alterations in length tended to predispose in these animals to apical pulmonary tuberculosis.

I should like to take this opportunity of thanking Dr. Chalmers Mitchell for the facilities he gave me for obtaining this series.

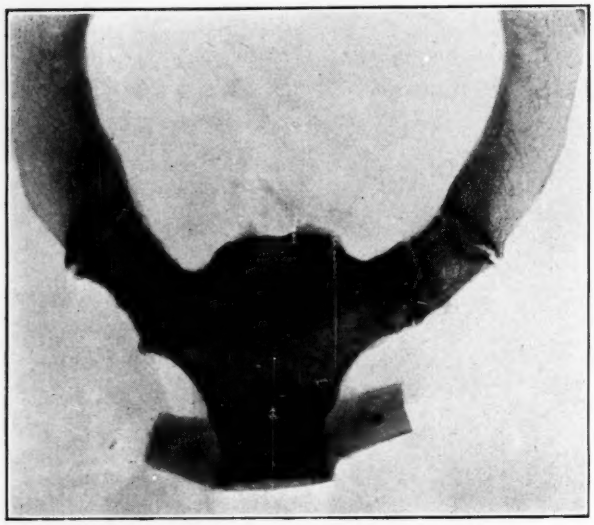


FIG. 30.—Male, aged 66. Marked ossification of both first costal cartilages. On the right side at the costo-chondral juncture there is a fracture that is practically healed. On the left side no fracture exists. (N.B.—The presence or absence of a false joint or fracture cannot be determined by radiographic examination alone.) The manubrium and sternum are directly continuous. Healed tuberculous lesions at the apices of both lungs.

The views propounded by Freund are briefly as follows :—

The aeration and nutrition of the apices of the lungs are dependent on the movements of the upper part of the thorax (the upper thoracic opening), and the adequacy of these movements is to a great extent dependent on the length and elasticity of the first costal cartilages. During inspiration the raising of the sternum is associated with a torsion of these cartilages. The freedom of movement is necessarily, therefore, dependent on the capacity of these structures to undergo spiral rotation. Abnormal shortness or ossification in the costal cartilages must interfere with this capacity, and the aeration and nutrition of the lung is thereby interfered with and a predisposing factor for the development of tubercle established. Freund shows further, that the first rib and cartilage are intimately connected with the shoulder, clavicle, and scapula. If the cartilage does not develop fully, there is imperfect expansion of the upper part of the chest, and the condition known as "habitus phthisicus" occurs. As a result of the interference with the movements of the upper thoracic opening there is a compensatory hypertrophy of the scaleni, which in turn

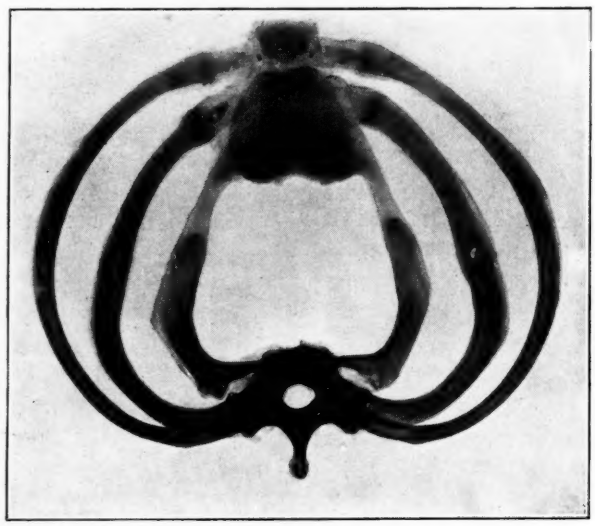


FIG. 31.—Chæma Baboon, aged about 4 years. No ossification in first costal cartilages. The apices of both lungs are normal.

leads to an inflammatory change in the perichondrium, and later, to ossification and complete rigidity of the first costal cartilage.

Freund not only maintains that the rigidity of the first rib cartilages is a strong predisposing factor to the development of apical tubercle, but further, that when fracture of the ossified cartilage occurs, with formation of a false joint, there is marked tendency for the apical tubercle to clear up.

Schmorl drew attention to the existence, in a certain proportion of cases, of a groove on the posterior and outer aspects of the apex of the lung caused by the pressure of the first rib, and showed that one of the three common places for apical tubercle to begin at, was in this groove. Freund regarded this as further evidence in support of his hypothesis.

The results of my investigations tend to show quite clearly that, whilst apical tuberculosis is found in people with abnormally short or ossified cartilages, this association is incidental only, and not one of cause and effect. Ossification found in the first costal cartilages is directly dependent on the age and sex of the subject.

The first difficulty that presented itself to me was the determination of what constitutes abnormal shortness in the first costal cartilage. Freund regards a length below 3 cm. as short for an adult male, and gives the average length as 3·8 cm. for a man, and 3·1 cm. for a woman. My figures work out at considerably less than this. In males an unossified first cartilage was found 44 times on the right side, average length 3·160 cm., and 44 times on the left, average length 3·294 cm. ; in females 50 times on the right side, average length 2·776 cm., and 51 times on the left, average length 2·885 cm. *Table I* on the following page gives the lengths of the normal and ossified cartilages (to the nearest decimal point) in the University College Hospital consecutive series of 125 cases. Three imperfectly developed cartilages are omitted.

This table shows the very striking fact that ossification is not only not more prone to develop in short cartilages, but that the ossified cartilages include the longest in the series. One cartilage is recorded of 0·75 cm. in length, and one of 1·25 cm. ; in both of these the extreme shortness is apparent only, and is due to the extensiveness of the ossification which has replaced the cartilage. In the tables given in this paper a short cartilage is arbitrarily taken to mean one below 2·5 cm. in length. Out of 247 specimens in *Table I*, twenty-eight cartilages were below this standard of length. Thus 11·3 per cent would come in the class " abnormally short."

In *Table II*, *p.* 63, is shown the relative frequency with which normal lung or healed or active apical pulmonary tuberculosis was found in association with the various types of changes in the first costal cartilages. The figures are obtained from the 125 consecutive cases from University College Hospital ; twenty-two cases from the Infirmaries ; twenty-seven cases from the City of London Hospital. The cases excluded from this list are the series of twenty-five children from University College Hospital and two cases in which there was marked abnormality in the development of the cartilage.

A careful study of this table will show that there is no decided association of any particular form of change as regards ossification or abnormality in length with either healed or active tuberculous lesions of the lung. It will be seen, indeed, that in the male group only 56·6 per cent of the cartilages found in association

with a normal apex showed no abnormality, while in the female series the proportion of normal cartilages in conjunction with normal lung or with active apical tuberculosis, is almost the same (74·6 and 75 per cent).

Table I.—Giving the Lengths of the Normal and Ossified Cartilages

Size in cm.	Sex	Normal Cartilages	Ossified Cartilages
4·25	M.	—	1
	F.	—	—
4·0	M.	1	3
	F.	—	—
3·75	M.	7	7
	F.	—	—
3·5	M.	21	17
	F.	6	4
3·25	M.	12	9
	F.	12	3
3·0	M.	9	13
	F.	19	7
2·75	M.	4	13
	F.	16	4
2.5	M.	5	3
	F.	14	9
2·25	M.	2	5
	F.	9	2
2·0	M.	—	1
	F.	5	—
1·75	M.	—	—
	F	2	—
1·5	M.	—	—
	F.	—	—
1·25	M.	—	—
	F.	—	1
1·	M.	—	—
	F	—	—
0·75	M.	—	—
	F.	—	1
	Total	145	102

If now one considers this same series of cases divided into three groups according to age (*Table III*)—Group 1, ages 10 to 30; Group 2, ages 31 to 50;

and Group 3, ages 51 to 82—it will be seen that with advancing years there is an increase in the number of cases showing healed and active tuberculous lesions at the apex, the percentage of these cases to the total number in each group being 45·3, 57·6, and 72·4 in groups 1, 2, and 3 respectively. This increase bears no comparison, however, with that shown by taking the percentage of abnormal cartilages found in conjunction with healed and active disease at the apex, in the three groups. The figures are 18 per cent in Group 1, 50 per cent in Group 2, and 85·5 per cent in Group 3.

Table II.—Showing the Relationship of Normal Lung, Healed Tubercle, and Active Tubercle in the Apex of the Lung, to the Condition of the Cartilage in 174 Cases.

Sex	Total	Condition of Lung	Condition of the First Costal Cartilage.										
			Normal	Short normal	Short normal with joint	Slight ossification	Short slight ossification	Slight ossification with joint	Marked ossification	Short marked ossification	Short marked ossification with joint	Marked ossification with joint	Percentage of normal to abnormal
M.	82	Normal	46	2	—	15	—	—	15	—	—	4	56·6
F.	71		53	7	1	5	1	2	—	—	1	1	74·6
M.	91	Healed tubercle	24	3	—	32	1	5	9	—	3	14	23·6
F.	56		31	6	—	4	—	5	1	1	—	6	55·3
M.	61	Active tubercle	22	1	—	16	—	3	11	1	—	7	36·0
F.	24		18	1	—	1	—	2	2	—	—	—	75·0

The total in this table exceeds the number of cases, as whenever both healed and active lesions were found, the condition of the cartilage is given under each heading.

Table III.—The Same as *Table II*, but the Cases are Divided into Age Groups.

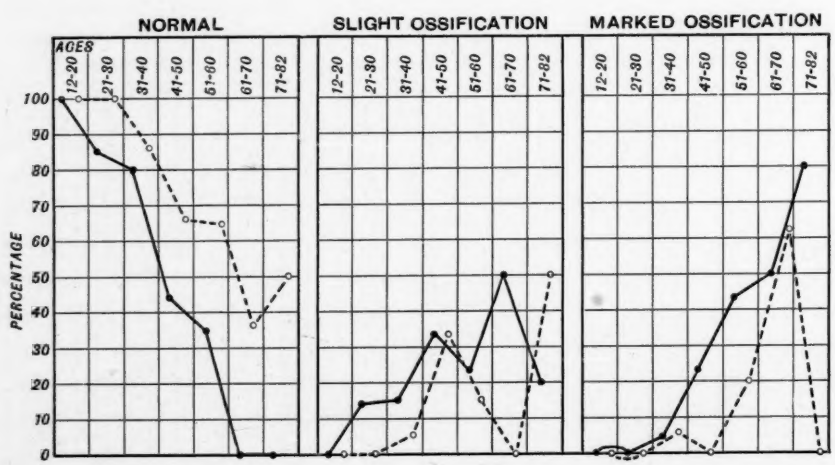
Sex	Total	Condition of Lung	Condition of First Costal Cartilage									
			Normal	Short normal	Short normal with joint	Slight ossification	Short slight ossification	Slight ossification with joint	Marked ossification	Short marked ossification	Short marked ossification with joint	Marked ossification with joint
Ages 10 to 30.												
M.	23	Normal	21	2	—	—	—	—	—	—	—	—
F.	24		22	2	—	—	—	—	—	—	—	—
M.	9	Healed tubercle	6	—	—	3	—	—	—	—	—	—
F.	6		5	1	—	—	—	—	—	—	—	—
M.	18	Active tubercle	16	—	—	2	—	—	—	—	—	—
F.	8		7	1	—	—	—	—	—	—	—	—

[*Table III continued over.*

Table III—continued.

Sex	Total	Condition of Lung	Condition of First Costal Cartilage									
			Normal	Short normal	Short normal with joint	Slight ossification	Short slight ossification	Slight ossification with joint	Marked ossification	Short marked ossification	Short marked ossification with joint	Marked ossification with joint
Ages 31 to 50.												
M.	37	Normal	18	—	—	11	—	—	8	—	—	—
F.	32		23	3	1	3	—	2	—	—	—	—
M.	28	Healed tubercle	9	3	—	12	—	2	1	—	—	1
F.	31		21	2	—	1	—	4	1	—	—	—
M.	22	Active tubercle	6	1	—	10	—	2	2	—	—	1
F.	13		11	—	—	—	—	—	2	—	—	—
Ages 51 to 82.												
M.	22	Normal	7	—	—	4	—	—	7	—	—	4
F.	15		8	2	—	2	1	—	—	—	1	1
M.	54	Healed tubercle	9	—	—	17	1	3	8	—	3	13
F.	19		5	3	—	3	—	1	—	1	—	6
M.	21	Active tubercle	—	—	—	4	—	1	9	1	—	6
F.	3		—	—	—	1	—	2	—	—	—	—

Table IV—(University College Hospital Series of 125 Consecutive Cases) Showing the Increase of Ossification with Increase in Age.*



* The black line denotes the percentage in the male subjects, the dotted line the percentage in the female subjects.

It is this striking increase in the proportion of abnormal to normal cartilages with increase in age which offers a suggestion as to the cause of ossification in the cartilages.

A glance at *Table IV* must at once make it apparent that ossification of the first costal cartilage develops earlier and to a greater extent in men than women, and that increase in age is associated with an increase in ossification.

To test these results, 100 consecutive radiograms of the upper part of the chest, taken for quite other reasons, were examined, and the condition of the cartilage was noted; the age and sex of each of the patients were then looked up, and the records are shown in *Table V*.

Table V.

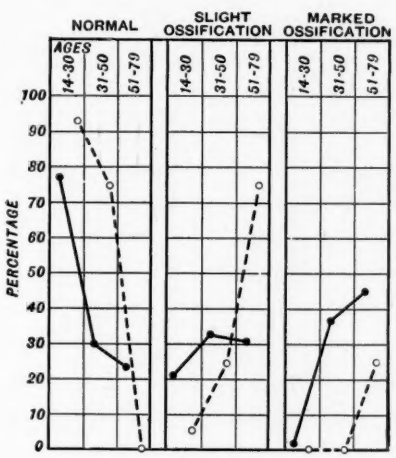
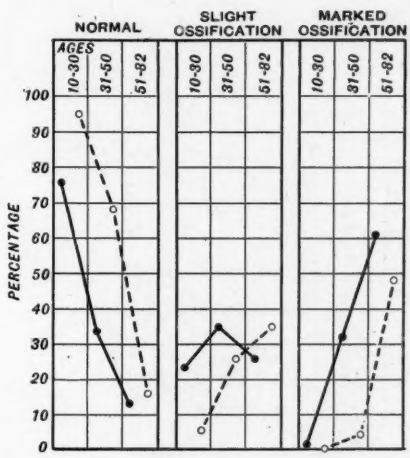


Table VI.



Lastly, *Table VI* shows this age, sex, and ossification relationship in 748 cases, composed of the 450 cartilages above recorded, together with the 98 cartilages from the City of London Hospital and Infirmary series, and 200 cartilages the details of which are given by Jungman (*Frankf. Zeitsch. f. Path.*, Bd. 3, s. 938).

Thus it will be seen that in both sexes, with increase in age there is a steady decrease in the number of normal first cartilages and a steady increase in the number showing marked ossification. In the male, the percentage of cartilages showing slight ossification increases up to middle life, and then decreases again, this latter change coinciding with the rise in the percentage of cartilages showing marked ossification. In the female, on the other hand, the percentage of cartilages with slight ossification increases steadily throughout life.

The Manubrio-sternal Joint.—Keith says that " the manubrio-sternal joint must be counted amongst the important respiratory joints." Absence of movement at this sternal articulation favours, in Rothschild's opinion, the development of apical tuberculosis, by limiting the movements of the upper thoracic opening. Freedom of movement undoubtedly facilitates expansion of the apex of the lung, but the absence of it does not appear to me to predispose to apical tuberculosis.

In 74 cases the range of movement obtained in the fresh specimen varied from 0° to 22°, the average being just over 4°.

In *Table VII* is shown the relative proportion of the various changes in the first costal cartilage to normal, healed, and active tuberculosis of the apex in the 74 cases in which the degree of movement of the sternal angle was noted. The table is divided into two parts: *Part A*, cases with movement at the sternal angle of 6° or more; and *Part B*, cases with movement of 5° or less. The ages recorded are from 14 to 75.

Table VII.—Showing the Influence of Movement of the Sternal Angle.

Part A.—Cases in which Sternal Angle shows movement of 6° or more.

Sex	Total	Percentage	Condition of Lung	Condition of First Costal Cartilage									
				Normal	Short normal	Short normal with joint	Slight ossification	Short slight ossification	Slight ossification with joint	Marked ossification	Short marked ossification	Short marked ossification with joint	Marked ossification with joint
M.	12	44·7	Normal	8	—	—	4	—	—	—	—	—	—
F.	9			6	—	—	3	—	—	—	—	—	—
M.	13	47·5	Healed tubercle	7	—	—	5	1	—	—	—	—	—
F.	7			7	—	—	—	—	—	—	—	—	—
M.	2	12·8	Active tubercle	—	—	—	2	—	—	—	—	—	—
F.	4			4	—	—	—	—	—	—	—	—	—

Part B.—Cases in which Sternal Angle shows movement of 5° or less.

M.	27	46·0	Normal	12	—	—	3	—	—	8	—	—	4
F.	24			18	3	—	1	—	—	—	—	1	1
M.	23	43·2	Healed tubercle	6	—	—	6	—	1	4	—	2	4
F.	25			14	2	—	2	—	5	1	—	—	2
M.	6	10·8	Active tubercle	2	—	—	—	—	—	2	—	—	2
F.	6			3	1	—	—	—	—	2	—	—	—

The first point to which attention must be directed in this table is the fact that the percentage of cases of normal lung and of healed and active apical lesions is practically the same in both series, i.e., in *Part A*, in which the movement at the sternal angle is above the average, and *Part B*, in which the movement is below the average, such difference as does exist being as a matter of fact in the direction of fewer cases of active tuberculosis in association with those cases where the range of movement of the sternal angle was 5° or less.

The most striking fact, however, is the total absence of marked ossification changes in the cartilages of those cases with a movement at the sternal angle of 6° or more, and the presence of these changes, in considerable number, in the

cases with a movement of 5° or less. But this phenomenon is explained in *Table VIII*, in which the cases are divided into age groups, and in which it will be seen that the great majority of patients with a movement at the sternal angle of less than 5° are elderly.

Table VIII.—Proportion of Cases out of 74 in which Movement at Sternal Angle is 6° or More, or 5° or Less, According to Age.

Sex	Total	Movement 6° or Over	Movement 5° or Under		Ages
M.	8	4	4	62·5%	14 to 30 years
F.	8	2	6		
M.	13	6	7	66 %	31 to 50 years
F.	19	6	13		
M.	20	3	17	88·4 %	51 to 75 years
F.	6	0	6		

I have already shown that the extent of ossification of the first costal cartilage is directly dependent on the age and sex of the patient, and *Table VIII* shows that while 62·5 of the cases under 31 years have a range of movement in the sternal angle of less than 5°, and 66 per cent of the cases between the ages of 31 and 50, no less than 88·4 per cent of people over 50 years old show this limitation of movement in the sternal angle.

In 14 cases there was no movement at all obtainable in the sternal angle. One of these was a woman of 21, one was a woman aged 32, and the remaining twelve were over 50 years old. In the 28 lungs from these cases, active apical tuberculosis was found in 4, healed tuberculous lesions in 13, and the lung was normal in 11 ; this despite the fact that the associated first costal cartilages showed marked ossification in 14, slight ossification in 6, and no ossification in 8; and of these latter 1 was 2·5 cm., and another only 2·1 cm. long.

Causation.—Freund has shown that the ossification involves mainly the anterior aspect and the upper and lower borders of the first costal cartilage, and considers the immediate cause of the process to be the constant pull of the scaleni muscles and the resultant irritation of the perichondrium. While disagreeing with Freund as to the reason for this constant straining action of the muscles, I think that it is quite probable that the ossification is due to a long-continued very slight irritating action, not only of the scaleni muscles, but also of the intercostals of the first space and of the subclavius muscle and costo-coracoid ligament, both of which are inserted into the anterior aspect of the first cartilage. The evidence that the condition of ossification develops with increasing years and is more marked in the male than in the female, indicates that the primary cause is probably directly connected with occupation, and is not dependent on such a factor as length, which should exercise equal influence in the two sexes.

The "Schmorl" Groove.—Schmorl called attention to the occasional presence of a groove on the posterior and outer aspect of the lung at the level

of the first rib, and Freund considers that this groove is caused by the pressure of the rib as a result of the diminution of the size of the upper opening of the thorax from abnormal shortening of the costal cartilage.

Certain criticisms at once present themselves. The hypothesis seems to suggest that the size of the lung is predetermined, and that had the first costal cartilage been of average length, the lung would have fitted comfortably into the upper opening; but that during development, the first cartilage had not attained its correct length, and the lung is constricted therefore by the rib. Such a method, however, does not accord with the general principles of development; but rather an apparent constriction of the lung at the upper opening and an "overflow" above and below the first rib, is what would be expected if the lung were to increase in size after development had ceased, as in emphysema. *Table IX*, which records the presence or absence of a groove on the surface of the lung and the size of the cartilages in 119 specimens, does not in any way support Freund's hypothesis.

Table IX.—Showing the Presence or Absence of a Groove on the Lung and the Size of the Cartilages.

Sex	Cartilages Size	Lungs		Sex	Cartilages Size	Lungs	
		Grooved	Not Grooved			Grooved	Not Grooved
M.	2·5 cm. and over	32	37	M.	3 cm. and over	27	27
F.		17	22	F.		12	11
	Total	49	59		Total	39	38
M.	Under 2·5 cm.	1	3	M.	Under 3 cm.	7	14
F.		5	2	F.		10	11
	Total	6	5		Total	17	25

In the specimens from children ranging in age from eleven days to ten years, the average length of the first costal cartilage was 2·07 cm. in the right, and 2·12 cm. on the left side. The shortest was in a male three weeks old, the length of the right cartilage being 1 cm., and of the left 1·25 cm. Active tubercle was found at the right apex of a girl one year old with a cartilage 2 cm. long, and healed tubercle was found at the left apex of a boy aged eight, and at the right apex of a girl aged ten years. In both cases the corresponding cartilage was above the average length.

No evidence of any ossification was found in the cartilages of the seventeen primates examined, although both first costal cartilages of a female white-cheeked mangaby, aged about six years, showed central calcification.

SUMMARY.

1. Neither abnormal shortness nor ossification in the first costal cartilage predisposes to apical pulmonary tuberculosis.

2. Abnormal shortness of the first costal cartilage does not encourage ossification in that cartilage.

3. Ossification in the first costal cartilages is dependent on age and sex, and probably occupation.

4. With increasing age, there is increasing limitation of movement of the sternal angle.

5. Limitation of movement of the sternal angle does not predispose to apical pulmonary tuberculosis.

6. The presence of a groove in the posterior external aspect of the lung below the apex (Schmorl) is not the result of abnormal shortness of the costal cartilage, but probably of emphysema.

7. The formation of a false joint in the rigid cartilage does not tend to lead to the cure of apical tuberculosis: and therefore

8. The balance of evidence is against the probability of the operation for division of the first costal cartilage in cases of apical tuberculosis producing any material improvement.

REFERENCES.

FREUND, Beiträge zur Histologie der Rippenknorpel im normallen und pathologischen Zustande. Breslau, 1858.

FREUND, Der Zusammenhang gewisser Lungenkranheiten mit primären Rippenknorpelanomalien. Erlangen, 1859.

FREUND, Thorax Anormalien als Prædisposition zu Lungenphthise und Emphysem. *Verhandlungen der Berliner Medicinische Gesellschaft*, 1901, s. 463. (*Berl. klin. Woch.*, 1902, s. 29; *Therap. Monats.*, 1902, s. 1).

FREUND, Beiträge zur Behandlung der Tuberkulösen Lungenspitzenphthisen und des alveolären Emphysems durch operative Mobilisation des in der oberen Apertur stenosierten und des starr dilatierten Thorax. *Münch. med. Woch.*, 1907, s. 2369.

FREUND, Chirurgische Mobilisirung des Stenosirt und des dilatiert starren Thorax. *Verhandlungen des Deutschen Gesellschaft für Chirurgie*, 1910 s. 281.

HART, Die mechanische Disposition der Lungenspitzen. Stuttgart, 1906.

HART AND HARRASS, Der Thorax Phthisicus. Stuttgart, 1908.

JUNGMANN, Beiträge zur Freundschen Lehre vom zusammen-hange primärer Lungentuberkulose und Emphysem. *Frankfurter Zeitschrift für Pathologie*. 1909, s. 38.

KEITH, The Mechanism of Respiration in Man; in "Further Advances in Physiology" (Leonard Hill). 1909, p. 182.

ROTHSCHILD, Der angeborene Thorax paralyticus. *Verhandlungen des Kongresses für Innere Medicin*, 1906, s. 87.

ON RUPTURE OF THE CRUCIAL LIGAMENTS OF THE KNEE, AND ON FRACTURES OF THE SPINE OF THE TIBIA.

By ROBERT JONES, Liverpool,
and
S. ALWYN SMITH, Winnipeg.

Radiography has proved to our satisfaction that fracture of the spine of the tibia is much more common than is recognized in the literature on the subject. Often associated with this injury there is found rupture of one or other of the crucial ligaments. During the last three years we have carefully investigated a number of these injuries, and find that though the two may be connected, rupture of a crucial ligament without fracture of the spine of the tibia is a relatively common accident, and fracture of the spine may occur without any rupture of the crucial ligaments.

Fig. 32.—A, Separated fragment; B, Place from which it has come. 1, Internal semilunar cartilage; 2, Anterior crucial ligament; 3, External semilunar cartilage. (*Lent by Sir R. Godlee.*)

Although rupture of one or both of the crucial ligaments must frequently occur in dislocations of the knee joint, references to this subject in the literature are meagre. We have only found references to operative treatment made by Battle, Mayo Robson, Hogarth Pringle, Pagenstecher, and Robert Jones.

In 1907 Hogarth Pringle published an enlightening paper on the connection of rupture of the anterior crucial ligament with avulsion of the spine of the tibia, and reported a case in which the spine was stitched back into position. This is the first recorded operation for this injury, although in 1888 Rickman Godlee described the lesion, which he had found some years before in a leg amputated by Erichson in 1873. He stated that there had been several injuries caused by the passage of a cart wheel over the leg. Amputation was performed fourteen days later. On opening the knee-joint afterwards, a loose piece of bone was found separated from the top of the tibia, with the anterior crucial ligament and external semilunar cartilage attached to it (*Fig.* 32).

These cases apparently form the basis for Pringle's deduction that excessive traction on the anterior crucial ligament produces the fracture of the spine of the tibia, and he therefore calls the lesion " avulsion of the tibial spine."

During the last three years we have had the fortune to see seventeen cases of injury of the spine of the tibia ; and although we agree with Pringle that some cases are traction fractures, in other cases the chip of the bone detached does not include the area to which the anterior ligament is attached, so that some other cause must be sought for to explain them.

On the upper surface of the tibia the two articular facets turn upwards towards each other in the middle of the joint to form the two tubercles of the spine

FIG. 33.

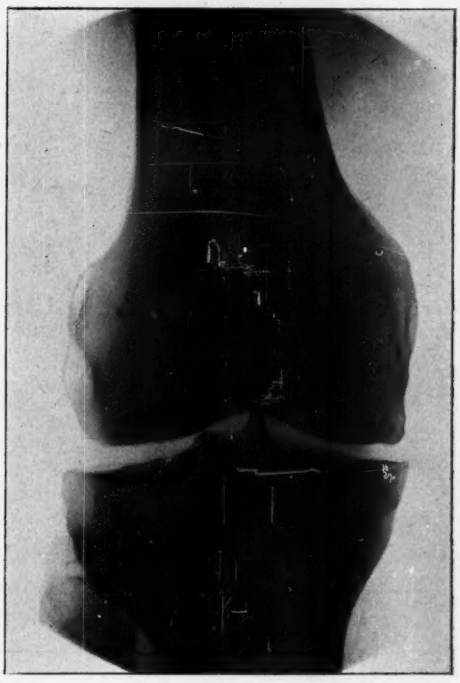


FIG. 34.

of the tibia. Along the summit of the spine a groove runs in an antero-posterior direction between the two tubercles, and opens out anteriorly and posteriorly into the V-shaped intercondylic fossæ.

Of the two tubercles, the inner is usually higher and longer in the antero-posterior direction than the outer, though the latter is usually more sharply pointed. They vary, however, in size, as is shown by *Figs.* 33 and 34, which are radiograms of healthy knees.

In certain forms of " rheumatoid arthritis," especially the hypertrophic type, the tubercles become more pointed than is normal. We have also noticed an *exostosis* growing from the tibia just in front of the spine, which might easily have been broken off to form a " loose body."

The anterior V-shaped intercondylic fossa of the tibia is wider than the posterior, and furnishes attachments for the anterior horns of the semilunar cartilages and for the anterior crucial ligament, which is situated slightly internal to the middle line just in front of the internal tubercle of the spine, to the base of which a few of its hindmost fibres are attached. The posterior intercondylic fossa of the tibia slopes downwards and backwards. The posterior horn of the external semilunar cartilage is attached to a surface which rises on to the back of the spine, the posterior horn of the internal semilunar cartilage is attached to its inner margin, while the posterior crucial ligament is attached to its posterior rounded surface.

From this attachment in front of the inner tubercle of the spine the anterior crucial ligament passes upwards, backwards, and outwards, to be attached, less strongly than to the tibia, to the inner aspect of the external condyle of the femur in the posterior part of the intercondylar fossa.

The posterior crucial ligament passes upwards, forwards, and inwards, behind the anterior ligament, to be attached in the front part of the intercondylar fossa to the outer surface of the anterior portion of the internal condyle.

Bearing these anatomical facts in mind, the important points to remember about the mechanism of the crucial ligaments are :—

1. The anterior crucial ligament is tense when the knee is fully extended, and prevents the tibia from being displaced forwards on the femur.

2. The posterior crucial ligament is tense in complete flexion, and prevents the tibia from being displaced backwards on the femur.

3. Both ligaments check inward rotation of the tibia.

Hence if, after an injury of the knee, the tibia can be displaced backwards or forwards or rotated inwards in the extended position, an injury of one or both crucial ligaments may be diagnosed.

If, in the extended position, the tibia cannot be displaced forwards, it may be assumed that the anterior crucial ligament is not torn across.

If in full flexion the tibia cannot be displaced backwards, the posterior crucial ligament is presumably not ruptured.

The history of an injury will help to exclude cases of abnormal mobility due to elongation or destruction of the ligaments associated with long-continued effusion into the joint, Charcot's disease, and locomotor ataxia. The diagnosis therefore of a ruptured crucial ligament should not be very difficult.

The most constant sign of fracture of the spine of the tiba is an obstruction to full extension. The block feels like a definite bony obstruction, and is quite different from the locking which occurs when a dislocated semilunar cartilage is nipped.

Pringle worked out the mechanism of his two cases, showing that tension on the anterior crucial ligament tore off the spine. As we do not find this a satisfactory explanation of the injury in all the cases we have seen, we offer the following classification.

1. *Avulsion of the tibial spine or its internal tubercle.*
2. *Fracture of the external tubercle of the spine.*
3. *Injury to the spine combined with fracture of a tuberosity of the tibia.*

1. AVULSION OF THE TIBIAL SPINE OR OF ITS INTERNAL TUBERCLE.

This is the only type of fracture of the spine which has been previously described. It is produced by violent tension on the crucial ligament, a mechanism similar to that which produces rupture of the crucial ligaments. We therefore propose to discuss rupture of the crucial ligaments in this section.

To cause rupture of both crucial ligaments extreme violence is necessary, such violence indeed as would produce complete dislocation of the knee joint. Battle describes a case in which he sutured both crucial ligaments which had been torn from their femoral attachments. In Mayo Robson's case, the injury was due to a fall of coal on to the patient's knee while working in a mine. Hogarth Pringle has seen two similar cases with laceration of the soft parts and rupture of the posterior and lateral ligaments of the knee.

We have seen a similar injury produced by forward displacement of the tibia in hyperextension, and also in cases where the tibia has been forcibly dislocated backwards and upwards. In one case of lateral dislocation caused by the leg being caught in the spokes of a revolving wheel, the injury had caused paralysis of both popliteal nerves. In all these cases of severe injury the knee is flail-like, the tibia can be displaced forwards in full extension, proving rupture of the anterior crucial ligament, while rupture of the posterior crucial ligament is demonstrated by displacing the tibia upwards and backwards into the ham with the knee fully flexed.

It is important to notice that firm union of the torn ligaments is usually obtained if the limb is kept at rest for a long period. Generally, if the limb is not seen for five to six weeks after the injury, and has been kept fixed during this period, abnormal mobility is not a striking feature of the case. Pringle states that in these cases abnormal mobility is again conspicuous if an anæsthetic is administered, but we have been unable to verify this statement in our cases.

Rupture of the posterior crucial ligament alone is a rare accident, but Pagenstecher has had one case which he treated by suture. Honigschmied found that this injury was not easily produced experimentally by means of hyper-extension of the knee. Pagenstecher found it could be produced by flexing the knee fully and then driving the upper end of the tibia backward; as a rule, the ligament was torn at its femoral attachment, though in some instances the bone on the tibia between the articular surfaces was torn out. Dittel, by flexing the knee and separating the tibia from the femur, obtained similar results, and once succeeded in tearing the spine away from the tibia instead of rupturing the ligament itself. We have never succeeded in doing this.

Rupture of the anterior crucial ligament was produced experimentally by Pringle. He first fixed the pelvis and flexed the knee, at the same time abducting the leg and rotating it inwards. He considers that the internal rotation is the most important factor in producing the rupture; but once the fibres have begun to tear, abduction plays a part by drawing the ligament across the sharp internal margin of the external condyle. It was found in all cases that the deep fibres of the internal lateral ligament were torn as well as the anterior crucial ligament. In both his clinical cases, Pringle found that marked abduction was possible, but there was not the freedom of internal rotation which was to be expected if the crucial ligament was torn. For this reason he expected to find a complete rupture

of the internal ligament only. At the operation, however, the anterior crucial ligament was found to be torn, and at any rate the superficial fibres of the internal lateral ligament were intact. This fact is interesting in connection with dislocation of the internal semilunar, for as one of us has pointed out, the deep fibres of this ligament, to which the internal semilunar cartilage is attached, run a very short course from the condyle to the tuberosity of the tibia, and are always injured when an internal cartilage is displaced. In short, the behaviour of these deep fibres in relation to injury is quite distinct from that of the long superficial fibres usually demonstrated in the dissecting-room.

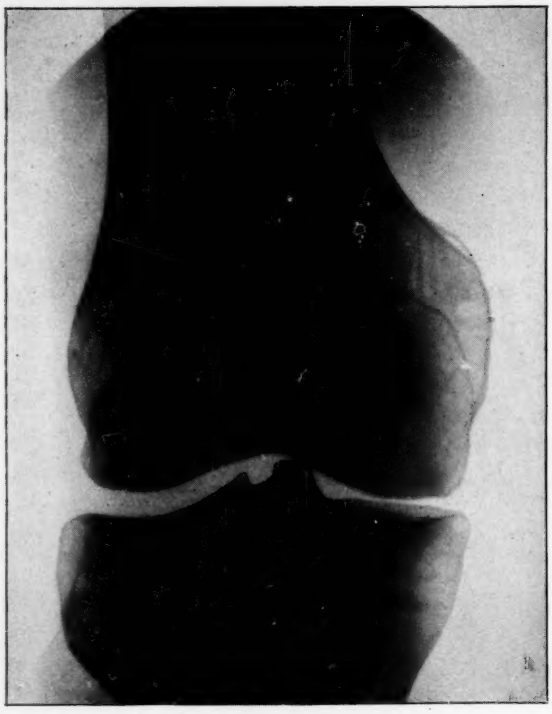


FIG. 35.

In a case recently operated on by Mr. R. E. Kelly in the Royal Infirmary, Liverpool, the skin of the inner side of the knee was dimpled as if nipped between the two bones, and yet the superficial fibres of the lateral ligament appeared to be intact at the operation. Both crucial ligaments were torn. A suture was loosely passed with the leg widely abducted, and tightened up as the leg was straightened. The case has so far done well, but the leg is still immobilized.

(We have lately examined this case, and find a useful limb which can be flexed almost to a right angle.)

Three cases of our series present symptoms similar to those just described, and of these we now relate the histories.

Case 1.—The first is that of a man who sought advice for a " slipping " knee. He stated that six years previously he slipped while turning quickly, and his knee was bent inwards. The case was diagnosed as a displaced semilunar cartilage, and since then the " slipping " has recurred with increasing frequency. At the original injury the knee did not strike the ground ; the foot was fixed and rotated outwards while the thigh was rotated inwards. When seen, the leg could be fully extended, but there was a great laxity of the joint, and the tibia could be rotated inwards with the leg extended, and also during forcible antero-posterior movements. The tibia could be displaced forwards a little when the joint was extended, and more when it was flexed to 30°. The posterior ligament was not torn, as no backward displacement could be obtained with the knee fully flexed. On placing the hands on the joint, the femur seemed to be suddenly displaced inwards just before extension was completed, and this constituted the " slipping " of which the patient complained. The radiograph (*Fig.* 35) shows a fragment torn from the inner side of the spine. Unfortunately the patient refused operation. A modification of the knee support originally described by Howard Marsh was fitted to prevent rotation of the tibia, but did not afford much relief. It is very doubtful whether the semilunar cartilage was ever displaced in this case.

Case 2.—A professional footballer was severely tackled, and fell " with his left leg doubled under him." After a few weeks the ill effects seemed to have passed away. He has played occasionally this season, but complains that the left knee " gives way." There is no history of anything slipping within the joint, and there never has been " locking." On examination, there was no laxity of, or pain over, the internal lateral ligament, but there was some pain on deep pressure on each side of the ligamentum patellæ. The limb was very muscular, and definite abnormal internal rotation of the tibia and antero-posterior movement could not be produced passively. The patient, however, could at will slide the femur forwards on the tibia in full extension, the condyles moving forwards and inwards. This was somewhat painful, and constitued the disability of which he complained. The *x*-ray (*Fig.* 36) shows a trace of roughening at the inner margin of the external condyle, and also at the spine of the tibia, as if some fibres of the crucial ligament had been torn and bony overgrowth had occurred. Operation was strongly advised in view of his calling, but was declined.

FIG. 36.

Case 3.—An athletic and muscular young Frenchman two years previously fell and twisted his knee while on service in the French Army manœuvres. He was invalided for a few weeks, but there was no history indicating a displaced semilunar cartilage. He complained of " slipping " of the knee joint and came for advice regarding a support to enable him to play tennis. The joint was very lax, and in full extension 5° of abduction with marked internal rotation of the tibia was permitted, and the tibia could also be displaced forwards. There was also some backward movement of the tibia in full flexion, showing that both crucial ligaments had been injured. The disability of which he complained was antero-internal displacement of the femur with the knee fully extended, which interfered with his athletic pursuits. In this case a " knee cage " proved of benefit.

In the last two cases we suggest that the crucial ligaments have been weakened and elongated. The subjects were both very muscular, or perhaps the weakness of the knee would have had more pronounced effects. In all the preceding cases the injury of the spine of the tibia has been trifling, and their symptoms are those which are characteristic of injury of the crucial ligaments.

The next case is interesting because, in addition to the signs of injury of the crucial ligaments pointed out by Pringle, it also presents a feature which has been a prominent sign in all our other cases, namely, inability to extend the leg fully : a sign which we regard as suggestive of fracture of the spine.

Case 4.—A farmer's wife had her knee injured five days before we saw her. A cow slipped, and its sides struck the inner side of the patient's right knee, knocking her down and crushing the limb between the animal and the side of the stall.

The knee was extended at the time, and the direction of the force would tend to produce genu varum. On examination, there was much effusion into the joint, and

the discoloration of the skin of the thigh and leg gave some indication of the severity of the blow. The patient could not voluntarily extend the limb fully. On an attempt to extend it passively, there was much pain and distinct obstruction, and a grating sensation was felt. With the limb fully extended, genu valgum to 30° could be produced, accompanied by slight crepitus, and the tibia could also be displaced forwards on the femur. With the joint flexed to 90° the tibia could be moved backwards as well as forwards. Internal rotation of the tibia was much increased, and was accompanied with pain. The *x*-ray (*Fig.* 37) shows a fracture of the internal tubercle of the spine extending into the inner tuberosity of the tibia. It was obvious that both crucial ligaments were injured in addition to the fracture. Operative measures were contraindicated on account of the patient's age and the extensive injury to the surrounding tissues.

Rest was secured in the extended position by fixing the limb in a Thomas's caliper splint, in which the patient is still going about. The case was seen again nine weeks after the injury, and the result surpassed all expectations. The patient could extend the joint fully, and there was no abnormal mobility in any direction, showing that repair of the ligaments had taken place.

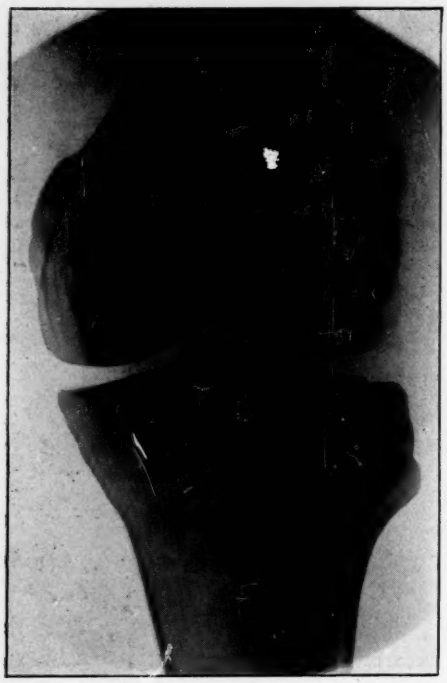


FIG. 37.

FIG. 38.

The *x*-ray (*Fig.* 38) shows a restoration of the bony contours, but there are two small masses of bone apparently free in the joint. It is impossible to state what symptoms, if any, may subsequently be produced by these.

The caliper splint will be discarded in a few weeks, and full restoration of function may be confidently expected, as there is already a range of 30° of flexion without any pain.

This case was seen soon after the injury and immediately placed in the fully extended position. There was therefore not enough time for a mass of firm new bone to be formed in the interval between the femur and tibia. Had the joint been

left for some time in a slightly flexed position, this new bone-formation would most probably have occurred, and would have proved an obstruction to full extension.

Three other cases belong to this section, but differ entirely from Pringle's case in symptoms.

The essential feature in all was an inability on the part of the patient to fully extend the limb. On attempting to extend the limb passively, the obstruction was felt to be bony, not soft. None of them presented abnormal mobility indicative of rupture of the crucial ligaments, even when tested under an anæsthetic. The reason for this was apparent in one case on which an operation was performed, for the anterior crucial ligament was found to be only partially torn. As far as we can discover, the mechanism was that described by Pringle, i.e., flexion, abduction, and rotation of the tibia either inwards or outwards. A short history of each of these cases follows :—

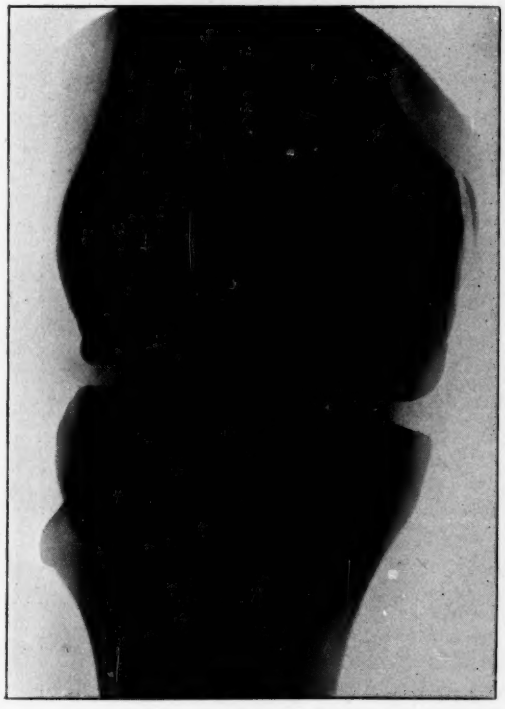


FIG. 39.

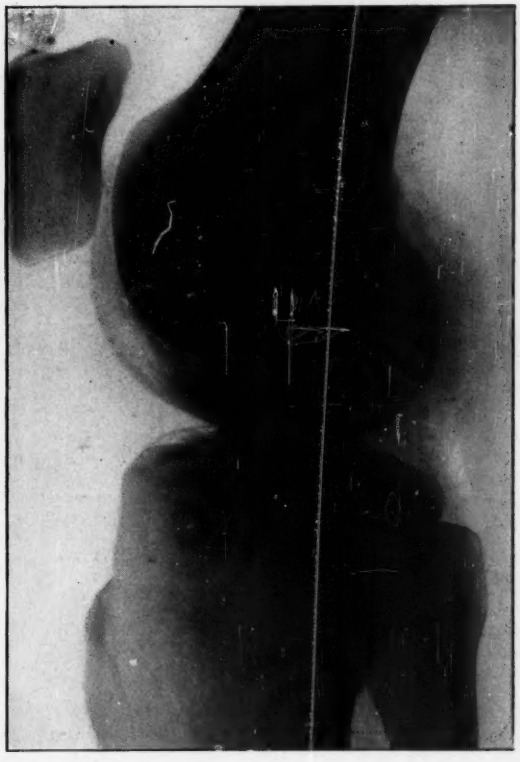


FIG. 40.

Case 5.—A man, aged 38, was thrown from his bicycle fourteen weeks before we saw him. He fell on his knee and then pitched forwards; the knee became distended with fluid, and he has never been able to extend it fully since. On examination the thigh muscles were wasted, and there was tenderness over the external lateral ligament. A diagnosis of displaced and unreduced semilunar cartilage was made, so an anæsthetic was administered in order to effect reduction. It then became manifest that the obstruction to extension was bony, not cartilaginous, and the true nature of the injury was revealed. The *x*-rays (*Figs.* 39, 40) show the internal tubercle of the spine intact, but the external tubercle much blurred by the formation of new bone. An incomplete fracture is seen extending into the base of the spine, showing that the force had

expended itself before the spine had been completely separated by traction. The knee was opened in the flexed position, and a large quantity of infrapatellar fat removed before a view of the spine could be obtained. The external semilunar cartilage was normal. The new bone which was attached to the tibia was chiselled away, some of the fibres of the anterior crucial ligament being sacrificed in the process. The main portion of the ligament, however, was left uninjured. After removal of the mass the limb could be placed in an almost straight position, but full extension was not recovered when the patient was last seen eighteen months later, more new bone having apparently been thrown out. This can only be classed as a partial recovery.

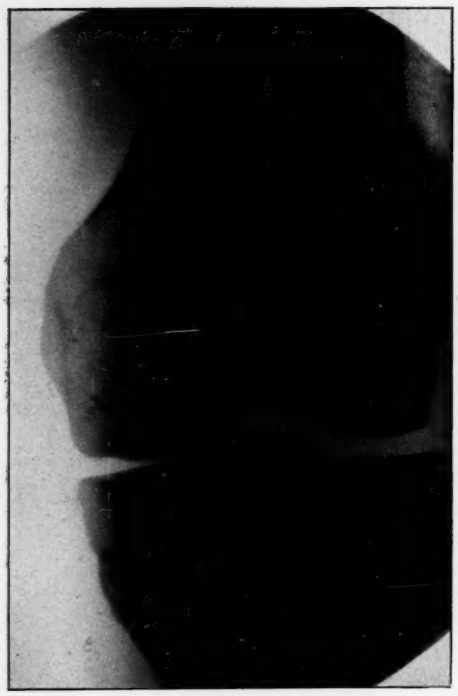


FIG. 41.

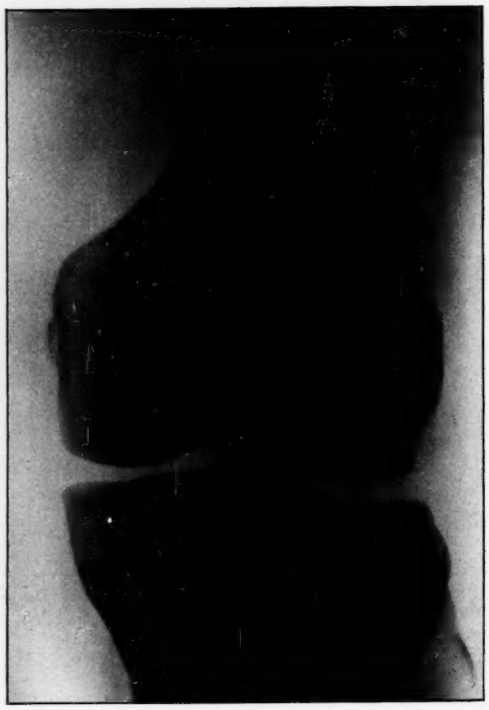


FIG. 42.

Case 6.—A drill sergeant, while doing gymnastics, fell from the horizontal bar on to the inner side of the right foot, and the leg slipped outwards. He felt sharp pain in the knee, and fell. He walked after the accident for about five hours, but the pain increased so much that he had to go to bed. The knee was now very swollen, tense, and sore. Pain and swelling lasted a week; he remained in bed a fortnight longer. He then returned to duty, but found he could not extend the knee fully when coming to attention. On examination the knee locked at about 25° from full extension, and on attempting passive extension "grinding pain" was complained of. The *x*-ray (*Fig.* 41) shows fracture of the internal tubercle, and possible involvement also of the external. Operation was not performed; the limb was rested and attempts made to straighten it, but full extension has not yet been obtained.

Case 7.—A gentleman, aged 65, while walking in his park three weeks ago, was tossed over some railings into an adjoining field by one of his own stags. He turned a somersault and fell on soft grass on to the front of the fully-flexed knees. Naturally he was much shaken, but was able to be up next day, and thought that his most serious injury was a sprained back. Although he has since walked about with some freedom up and down stairs and about his grounds, which are

hilly, without much pain, he has found himself unable to straighten his right knee fully. Three days ago he felt a sudden sharp pain in his right knee, which has since become worse. The pain is considerable while he is lying on his back, and to relieve it he crosses his right leg over the left so as to flex the right knee slightly. On palpation, there is tenderness over the insertion of the biceps and over the anterior horn of the internal semilunar cartilage. The *x*-ray (*Fig.* 42) shows a fracture of the inner tubercle of the spine. The limb was forcibly straightened and fixed in this position on a posteror splint for a fortnight. Later a knee cage was fitted and the limb was massaged for some weeks.

A nearly normal range of movement has resulted.

FIG. 43.

In the absence of characteristic signs of rupture of the anterior crucial ligament, it iis to be presumed that in this case, as in the two recorded previously, the injury to the ligament was only partial. In the appearance of this fracture there is nothing to suggest avulsion of the spine, and comparing it with Case 5, we are led to think that the mechanism is similar to that which we believe produces fracture of the external tubercle of the spine, which will be described in the next section. We suggest that the tip of the spine in this case was shorn off from behind forwards by the outer edge of the internal condyle. In full extension of the knee it is well known that there is a slight rotation of the femur inwards on the tibia, the so-called screw movement, and before the joint can be flexed this screw movement must be reversed. Assume that a person is thrown forwards on the flexed knees with the feet turned inwards, and with his knees and feet forced against the ground. The body still goes forwards by its own momentum till the patient measures his length on the ground. The knees are thus forcibly extended while the feet are still pressed on the ground and the leg is internally rotated, the toes being also fixed in inversion. Instead of the condyle circling round the spine at the end of extension—performing the screw movement—it impinges on the back of the internal tubercle of the spine and fractures it.

Case 8.—This case, which presented typical signs of rupture of the crucial ligament, is recorded on account of certain interesting features. A boy received a compound injury of his left knee by the bursting of a toy cannon on Guy Fawkes' day. He was treated in the country, where there were no radiographic conveniences. As the wound near the internal condyle was still discharging three months later, the joint was opened, when a large piece of the cannon was removed from the intercondyloid region. Abnormal movement typical of ruptures of the anterior crucial ligament was present. There was a mild septic arthritis, but the *x*-ray (*Fig.* 43) showed

roughening of the spine, indicating that the fragment of metal divided the anterior crucial ligament and chipped the spine at the same time.

As the joint is septic it is still being kept at rest.

Case 9. — When playing football a man, aged 31, was in the act of kicking the ball with the right foot, when someone jumped at him and brought the whole of his weight upon the patient's left thigh while in the extended position, and he fell backwards. He hobbled to the goal-post, and then when kicking the ball he felt something snap on the inner side of the knee, and he fell again. The knee was locked about 30° short of full extension, but he could bend it to a right angle, and it immediately commenced to swell. He was carried home. His doctor ordered massage.

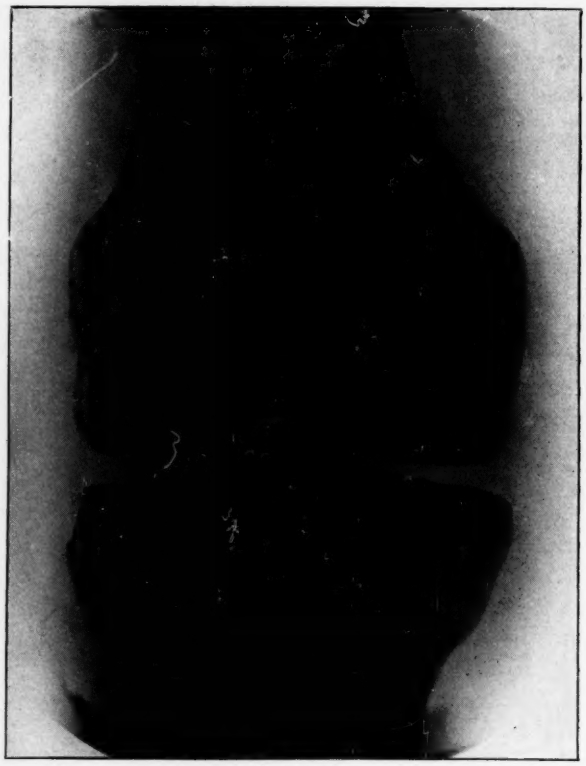


FIG. 44.

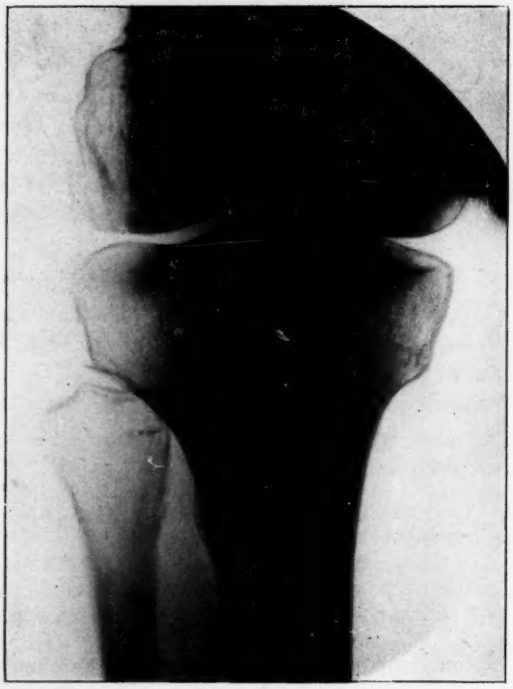


FIG. 45.

Nine days later he put on a back splint, which he wore for three weeks. The patient then commenced to walk, aided by crutches, but could not put his weight on the knee, which gave way under him. He did not have pain, but after knocking about for some time, swelling commenced on each side of the ligamentum patellæ. We first saw him seventeen weeks later, and found he had slight fullness on each side of the ligamentum patellæ. He was unable to extend his knee, and complained of great pain in the centre of the joint when he made the attempt to extend it fully. There was tenderness on pressure over the inner side. Suspecting a fractured spine, we explored the joint by a small lateral incision. Some portion of the infrapatellar fat was removed, but no piece of bone could be found lying there, although the *x*-ray (*Fig.* 44) demonstrated its presence. The cartilage was fixed by catgut

suture, and the knee was fixed in full extension. The patient made a complete recovery.

We have no doubt that had we made a vertical incision through the patella, the bone would have been found. In this case, however, it seemed to have made no difference.

Case 10.—A footballer injured his knee while playing in April of last year. He rested it until the following October. In that month he again injured his knee in a collision, but could not remember the direction of the causative force. We saw the case for the first time in February of this year. He had great pain over the internal lateral ligament, and pain when full extension was attempted. The *x*-ray (*Fig.* 45) showed a fracture of the spine. The piece was removed by the vertical approach and the knee fully extended. He is still under treatment.

2. FRACTURE OF THE EXTERNAL TUBERCLE OF THE SPINE.

This fracture, which has not been described previously, has been the cause of disability in three of our cases seen in the last few years. We believe that this fracture is not connected with injury to the crucial ligaments, for the fragment of bone broken off is very small, and is not in the region to which either of the ligaments is attached: this was clearly seen in one case in which the joint was opened. We believe that the tip of the external tubercle is shorn off from behind by the inner sharp margin of the external condyle, either by the femur being forced forwards or the tibia being driven backwards. As previously stated, the height of this spine varies greatly in different subjects (*Figs.* 33 and 34). It is the high type of spine which is liable to this injury. We had to examine a considerable number of dissecting-room subjects before we found a typical example of the high spine. Our idea was to notch the external tubercle with a small chisel and then see if we could complete the fracture by manipulating the joint. Our surprise was great when we found that in a cadaver we happened to examine the tip of the tubercle was already fractured, and fixed to the base of the spine by fibrous tissue only. *Fig.* 46 shows the raidograph of this specimen. Unlike other cases seen, the

FIG. 46.

fragment is not much displaced forwards, lying to the outer side of the anterior crucial ligament. The joint exhibits changes characteristic of the hypertrophic type of osteo-arthritis. The question therefore arose whether the whole condition was purely pathological. The opinion of several experts was obtained, including that of Goldthwait, of Boston, who happened to be visiting us, and who stated on seeing the specimen that he had never seen such a condition in any rheumatoid case. Experimenting on this joint by rupturing the internal lateral ligament, rotating the tibia outwards and abducting it, it was found that by rotating the femur slightly inwards and carrying it forwards, the inner sharp margin of the external condyle was forced against the posterior margin of the spine, and we thought that the tip had probably been separated in this way.

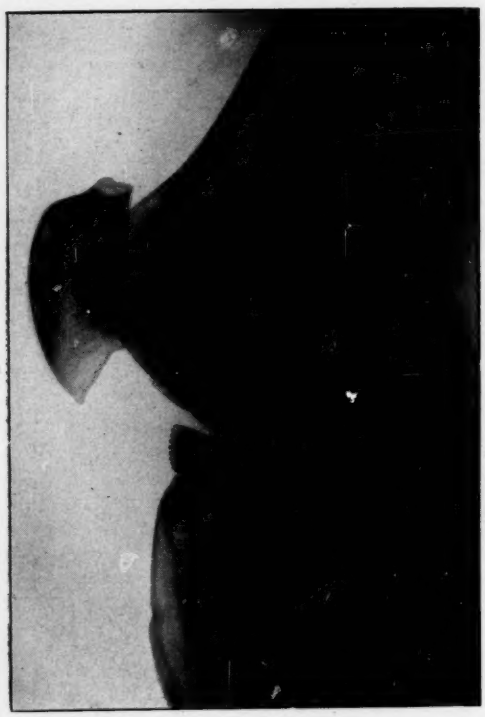


FIG. 47

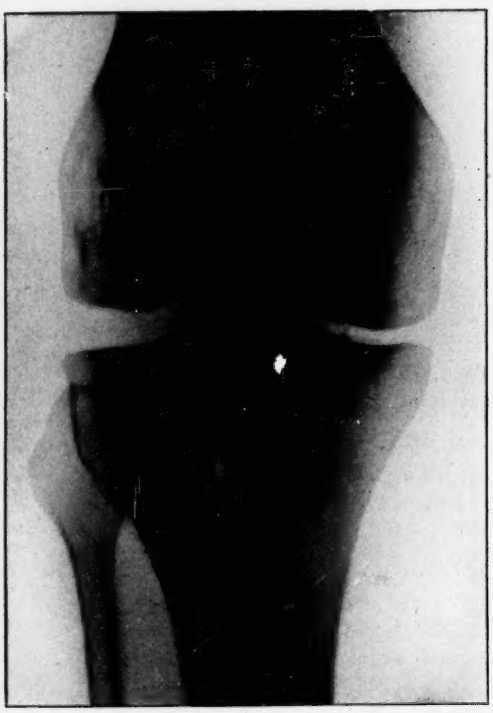


FIG. 48.

Further experiments on the cadaver showed that with the internal lateral ligament divided, the inner margin of the external condyle could be made to impinge on the spine without dividing the posterior ligament. The mechanism is therefore similar to that which produces a dislocation of the internal semilunar cartilage.

Case 11.—A young man injured his knee by a fall fifteen months ago, but cannot give precise details of the position of his limb. This was followed by effusion into the joint. When we first saw the case, movement was free except that the range was restricted by 15° from full extension. An attempt to extend the knee proved that there was a firm block, which caused great pain. The radiographs (*Figs.* 47, 48) show the injury to the external tubercle of the spine. The knee was opened by a straight incision on the outer side. The fragment of bone was removed with the scalpel from the outer side of the anterior crucial ligament, to which it was bound by

fibrous tissue, the use of a chisel not being necessary. The patient made a perfect recovery and returned to South America.

Case 12.—A farm labourer was run over three months ago. The wheel of a wagon passed over both knees, but the patient could not state the exact position of his limbs at the time. The right knee is now quite well, but the left still becomes swollen at times, and it is impossible to extend it fully. This movement is limited by 15°, but full flexion is permitted without pain. There is tenderness over both lateral ligaments. The *x*-ray (*Fig.* 49) shows that the external tubercle of the spine is fractured and displaced inwards. The knee also shows slight hypertrophic osteo-arthritic changes. The knee was forcibly extended under an anæsthetic, and fixed in that position for two weeks. After this massage and movement were assiduously employed, with the result that there is a distinct improvement in the range of movement.

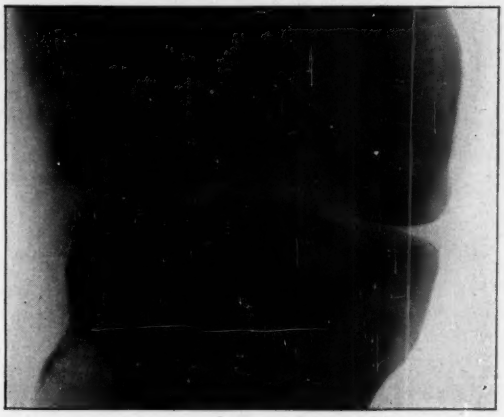


FIG. 49.

Case 13.—A man fell off a scaffold five feet high seven weeks ago. He dropped on to the inner side of his right foot, his knee bent inwards, his foot was rotated outwards, and in this position he collapsed on to the ground. There was effusion into the joint for two or three weeks, and he has not been able to straighten the limb fully since. There were no abnormal movements indicating rupture of crucial ligaments. In fact, the limitation of extension by about 15° was the only abnormality to be discovered. The radiograph shows that the external tubercle is displaced forwards (side view) on the tuberosity of the tibia.

FIG. 50.

Case 14.—In 1909, a young woman fell on a piece of wood with her knee at a right angle. She rested for some time, but when she began to walk she suffered great pain and was unable to extend her knee fully. She walked upon it for over a year, her knee becoming more flexed. She was operated upon—an exploration of the knee—in another city, but it resulted in increased lameness and stiffness. Two years after her accident we were consulted, and found the scar of a long vertical incision over the internal condyle of the femur. There was only about 20° of movement at the knee, which could not be fully extended. Tenderness was a marked symptom over the head of the tibia on each side of the ligamentum patellæ. There remained slight antero-posterior movement of tibia on the femur. Pain was acute on any attempt at complete extension. Fracture of the spine of the tibia was diagnosed, and was confirmed by the radiograph (*Fig.* 50).

3. INJURY TO THE SPINE COMBINED WITH FRACTURE OF ONE OF THE TIBIAL TUBEROSITIES.

We will refer only to two cases under this heading. In one case the external tubercle was fractured as well as the internal tuberosity, and in the other exactly the reverse occurred. The injury in each case seems to have been more severe, and the force applied more direct than in the cases previously discussed.

Case 15.—A workman in an iron foundry injured his right knee four months ago. He was sitting down working at some machinery on the ground, and his left leg was curled beneath the right one. The right foot rested flat on the ground with the ankle extended, and the leg was bent at about a right angle with the thigh. While in this position an iron bar weighing nearly a hundredweight fell directly downwards on to the region of the condyles of the femur. As far as the patient remembers, the knee was forced inwards, but of this he is not certain. Most of the force, however, was expended on the knee, and caused severe contusion in its neighbourhood, and in addition a jagged wound which did not heal for three weeks, during which time the patient was confined to bed. He could not straighten his knee after the accident, and it has remained flexed ever since. He has latterly gone about with crutches.

FIG. 51.

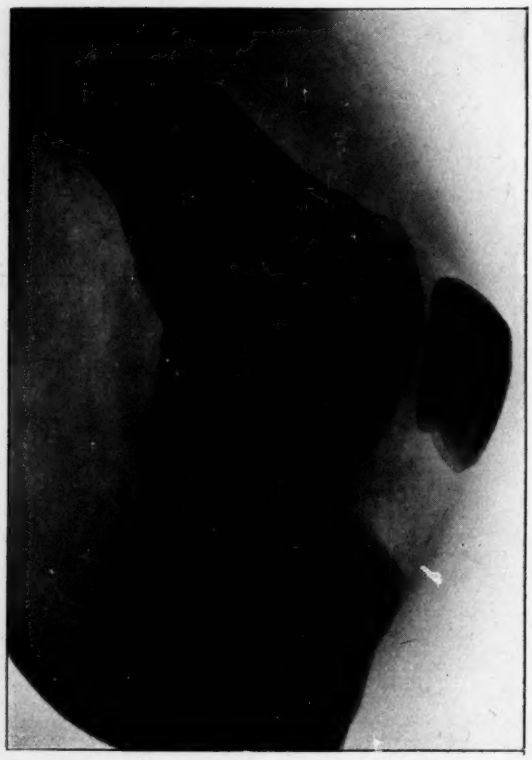


FIG. 52.

On examination it was found that the range of movement in the knee joint, while normal as regards flexion, was limited by 30° towards full extension. On palpation, marked thickening of the infrapatellar pad was noticed. The internal lateral ligament was defective, and permitted considerable abduction at the knee. There was no abnormal rotation of the tibia nor undue antero-posterior mobility of the joint.

The *x*-ray (*Figs.* 51, 52) shows a fracture mainly involving the external tubercle of the spine, combined with a crush fracture of the internal tuberosity of the tibia. At the operation we learnt that the mobility of the tibia may not always be present when the anterior crucial has been torn. Under the anæsthetic there was no appreciable sign that would have led us to believe that the anterior crucial was destroyed; yet on opening the joint we found a fibro-osseous mass lying in front of the intercondyloid eminence, which on removal was found to consist of a portion of the spine and the remains of a totally disorganized anterior crucial ligament. The joint is now very useful and the extension nearly perfect.

Case 16.—A man of 38, while cycling three months previous to being examined by us, was thrown headlong over the handles of his machine as the result of a collision. The left knee was badly damaged. As far as he could recollect, he fell on to the flexed knees. He was picked up and conveyed home to bed, where he remained for a fortnight. There was much effusion in the knee, and extensive bruising around it. He has since walked with the knee stiff but bent to an angle of 120°, that is to say, 60° from full extension.

On examination, the knee was found to be quite stiff, and there was some lateral displacement and rotation inwards of the leg. There was great pain on palpation over the internal lateral ligament, and intra-articular effusion, which was especially noticeable in the upper pouch. The radiograph (*Fig.* 53) showed a fracture of the spine through the inner tubercle, together with a crush fracture of the external tuberosity of the tibia, which was somewhat displaced in consequence, and rendered the head of the tibia wider across than normal. Stereoscopic radiographs showed the detached piece of bone lying in the middle of the joint.

FIG. 53.

It was decided to try the effect of manual correction of the deformity, with resection of the knee joint as an alternative, although no amount of joint mobility was prognosed. Under an anæsthetic the limb was with difficulty extended, but the lateral displacement of the tibia still remained. After four weeks' rest, massage and graduated movement were practised, with the most gratifying results. A good range of movement, about 60°, was obtained in a few weeks, and now complete extension of the joint with 90° of flexion is possible. The patient is now back at his original work.

In the main the mechanism of these two cases appears to be the same, although in the one the integrity of the anterior crucial was hardly doubted, whereas in the other case it was presumably destroyed.

The force in *Case* 15 was directly applied to the head of the tibia by means of the condyles of the femur. The blow, it would seem, fell in a downward and inward direction, so that the outer tubercle was first struck by the outer condyle, and the internal lateral ligament giving way at this instant, the rest of the force was expended on the internal tuberosity. The explanation of this is that the

antero-posterior dimension of the femur at the upper end of its trochlear surface is greater on the inner than on the outer side. The force probably ceased to act as soon as the knee bent inwards.

In Case 16 the force fell in a downward and outward direction.

The two cases we have just related are typical of several we have seen, and might be described as crush fractures of the tuberosity involving the tibial spines.

Rupture of the crucial must occur in many various types of dislocation of the knee. These dislocations are very uncommon, but one of us can recall many examples of such injuries during the last thirty years. As the after-results of these displacements of the tibia bear an important relationship to the subject of this paper, it may be well to relate the history of some of them.

One of the earliest cases was that of a shipwright, seen with the late Mr. H. Owen Thomas in 1882. The patient, who was between 20 and 30, would have fallen forwards over the side of a scaffolding, but he was prevented by the entanglement of his leg. His knee was thereby very forcibly hyperextended. He was seen by us an hour after the accident. His tibia was completely dislocated forwards and lay in front of the lower end of the femur; the joint was full of blood, and the whole limb was swollen and discoloured. No pulsation could be felt at the ankle, and we feared that amputation would be necessary. The dislocation was reduced without much difficulty, and the patient was placed by Mr. Thomas in the knee splint named after him. For six months he was fixed in the Thomas's caliper splint, which was then taken off at night and reapplied during the day, and in twelve months he had sufficiently recovered to carry on the arduous calling of a shipwright, which involves constant kneeling. In this case it is obvious that both crucials and the capsule were ruptured.

A few years later a case was seen in consultation with Dr. Adams. It was that of a policeman, whose foot was caught in a hurdle while jumping at sports. He twisted, fell on his back, and sustained a forward dislocation of the tibia, accompanied by paralysis of all the muscles supplied by the external popliteal. The knee was kept fixed in the fully extended position for four months, and shortly after full functional recovery occurred. The ankle was fixed in flexion to rest the paralyzed muscles for five months longer, and in twelve months he resumed his duties in the force.

Fifteen years ago (in consultation with Dr. Baines, of Southport), we saw a golfer, a heavy man, who dislocated his tibia forwards by catching his foot in a hole and falling forwards into a ditch. Reduction in this case was effected with difficulty, and during the manipulations the joint was found to be quite flail. Extension of the limb in a caliper splint resulted in an excellent recovery, and the patient (who was a man over forty) was able to play golf in less than a year.

We saw a very remarkable case of dislocation backwards of the tibia with the late Dr. Clampitt, at Bootle. The patient, a middle-aged sailor, had fallen from the rigging on to some soft cargo which happened to be on the deck. He was seen immediately on his arrival at Liverpool five days later. His foot was gangrenous up to his midtarsal joint, and the tibia was dislocated backwards. Reduction, which was difficult, could not be effected by the amount of traction which we considered safe; but on acutely flexing the limb, pushing the leg downwards, and at the same time straightening it, the reduction was comparatively

easy. Five days later, as the gangrene did not spread, the leg was amputated above the ankle. In a few months the patient was able to wear an artifical limb, with movement at the knee.

One other example will be given. It is that of a young man who attempted to jump a ditch while coursing at Waterloo. He said that as soon as he made a spring he felt something give, and he fell with his full weight upon the inner side of his knee. He was quite helpless, and his friend said that his leg was bent to right angles laterally. Examined under an anæsthetic, the knee could be easily abducted to 40 degrees. There was no fracture, but an almost complete rupture of the quadriceps extensor. From the description given to us by Dr. Houlgrave, we had no doubt that there had been a dislocation of the knee externally, and there was no doubt at all that the crucials were ruptured. Six months' fixation with subsequent massage resulted in what we should call excellent functional recovery.

These cases could be many times multiplied, but their object is attained if they prove sufficiently how well the crucials will recover if the limb be immediately and for many weeks kept at complete rest.

The experience of the older surgeons quite confirms our own in the reports they give of excellent recoveries following prolonged rest in dislocation of the knee.

In a conversation with Captain Pierpoint, I.M.S., he told us of an Afghan brought to him with a total backward dislocation of the tibia into the popliteal space. The knee was reduced and was quite flail. It was fixed in plaster-of-Paris for six months, and the result was a perfect restoration of function. He was last seen running up a rocky slope, jumping from rock to rock.

The above cases, we think, will completely answer the question as to whether an operation should be performed in a recent case of rupture of the crucials. We are emphatic in our opinion that it is wiser not to operate.

Rupture of the crucials as an accompaniment of dislocation of the knee is a graver injury than when it occurs without, and yet by suitable mechanical treatment a good functional result may be expected. The treatment should consist of absolute rest, and under no consideration whatever should active or passive movements be resorted to until from two to four months have elapsed. Even then it should be done most warily. The splint should be removed at night for some time and reapplied during the day. As soon as every flail element is eliminated, a short jointed splint should be applied to the knee, graduating the movement to twenty degrees at first, and then increasing it.

The present views on the surgery of joints are very harmful to injured ligaments. We know that four or five weeks are essential to their repair, and that any elongation or laxity allowed to remain means functional disability. We know furthermore that for the accurate repair of tendon or ligament no strain should be thrown upon them during the period of healing. Modern practice, however, merely pays homage, but not allegiance, to these facts. The fear of stiff joints has resulted in a policy of impatience. No sooner does an athlete fall than a rush is made upon him, and as soon as he reaches the pavilion the injured joint is subjected to vigorous assault. If the public could be taught that when an athlete injures his joint the limb should be protected from all movement until

an examination is made, the beginning of mischief would be avoided. If the practitioner will also learn that nothing but temporary stiffness follows even prolonged rest, he will need to exercise no hurry in beginning to move a joint before he has had time to make a careful diagnosis. We should have but few recurring displacements of the semilunars if the first injury were efficiently treated by resting the injured structures, more particularly the internal lateral ligament. The rupture of any of the ligaments of the knee should be treated by absolute rest until healing is complete. This of course applies with the greatest force to rupture of the crucial ligaments.

The management of old ruptures of the crucials which have not undergone adequate treatment requires some consideration. A certain proportion of such cases will very much improve by limiting strain on the injured ligaments, while others show a tendency to an increase of disability, more especially when lateral ligaments have also been badly injured. Quite a number of cases, however, show remarkably little disability, although they are able at will to push the tibia to and fro upon the femur. Such folk can even run and play games, without, of course, exhibiting any great proficiency.

In 1902 Mayo Robson reported a case upon which he operated in 1895 for the repair of torn crucials. The patient had met with his accident nine months previously. The head of the tibia could be brought forward in front of the femur, and there was free lateral movement of the head of the tibia on the femur. The joint was entered by an anterior flap, and both crucials were found torn from their upper attachments. The anterior was stitched in position by means of catgut ligatures to the synovial membrane and tissues on the inner side of the external condyle. The posterior being too short, was split in order to lengthen it, and was attached to the synovial membrane and cartilage on the outer side of the inner condyle. The result nine years later was surprisingly good.

In 1900 a barman consulted one of us, having fallen down some cellar steps four months previously and dislocated his knee. On examining the knee, the leg could be rotated inwards, but not outwards. The patient complained of pain whenever the knee was hyperextended, this being possible to a very limited extent. The tibia could be slightly displaced forwards in extension. We opened the joint by a free anterior incision, dividing the patellar ligament, and found a complete rupture of the anterior crucial, with considerable reddening of the synovial membrane. We freshened the ends, which were very frayed, and as they could not be brought together we plaited some chromicized gut to link the ends. For six weeks the patient was kept in bed, and in eight months after the operation the stability and mobility of the articulation were secured. In this case the ligament was ruptured below its femoral attachment, and thus differed from the usual separation so generally produced by experiment.

Looking back upon this case, we are inclined to think that the rest and fixation of the joint were the principal factors in producing so excellent a recovery.

We are of opinion that in a case of recent rupture of one or both crucials, fixation of the knee for a period of from three to six months offers the best chance of recovery, and that immediate operation should not be resorted to.

In neglected cases, where movement has been allowed early, we also think fixation of the joint should be first tried. The fixation should be continuous—not even a momentary relaxation being allowed.

In old cases such as that described by Robson, where pain, disability, and recurring effusions occur, the choice should lie between an operation for suturing the crucials, a mechanical support allowing flexion, or an arthrodesis of the joint. If the choice be in favour of suture, the capsule and ligaments should be made tense by reefing and stretching. Robson's case should be looked upon as very exceptional. It would be unreasonable to expect imperfectly repaired crucials to bear the great leverage to which they would be subjected in the presence of a lax capsule and lateral ligament.

Fractures of the tibial spine are more amenable to operative attack. If met with at once, the knee should be manipulated until full extension is secured. If there be no sign of laxity of the joint due to injury to the crucials or other ligaments, the fixation need not exceed two months. Good function may be confidently expected, in the absence of a bone block, to full extension.

When full extension is not possible, and disability exists in addition, whether it be pain, stiffness, or effusion, operation is to be recommended.

To obtain a good view and simplify the operation, we would recommend that the knee be flexed over the table at almost a right angle, and that a vertical incision be made through the patella. An incision is made starting an inch above the patella extending almost to the tubercle of the tibia. The patella is sawn vertically and its ligament split. The segments of the patella are separated to the border of the condyles (*Fig.* 54). The fat behind the patella is removed, when an excellent view may be had of the spine and the anterior crucial ligament. Any obstructive mass is removed, and the knee is straightened. The ligament of the patella, the aponeurosis, and the quadriceps extensor are stitched. No wire need be used for fixing the bone.

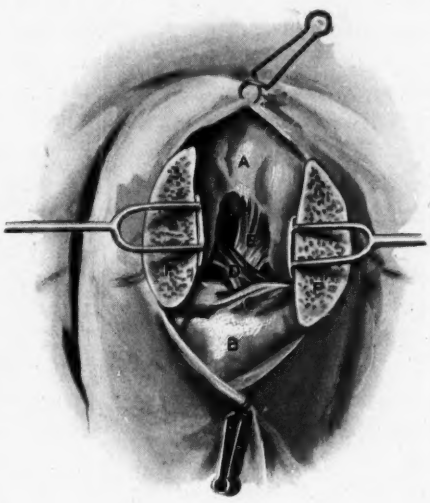


FIG. 54.

A, Femur; B, Tibia; C, Transverse ligament; D, Anterior crucial ligament; E, Posterior crucial ligament; F, F′, Cut halves of patella.

Arthrodesis of the knee, a perfectly justifiable procedure where the joint is very flail, is rarely called for.

REFERENCE.

Clin. Soc. Trans., xxxvi, 92.

INTRATRACHEAL ANÆSTHESIA.

By ROBERT E. KELLY, Liverpool.

Of the newer methods of anæsthesia, possibly none has evoked so much interest among surgeons as that of intratracheal administration, for not only is it a method of anæsthesia, but it has associated with it what might be termed a method of respiration as well. It is this combination of an anæsthetic apparatus with a respiratory apparatus which appeals to everyone who sees it for the first time, for the drug is administered by the oldest and best known portal of entry, namely, through the lungs; yet the dangers associated with inhalation, i.e., cessation of or obstruction to respiration, are both successfully overcome.

This method, originally introduced by Meltzer and Auer, was first used in the human subject by Elsberg, and has been extensively tried in America for the past two or three years.

Most writers on the subject have been much impressed with the value of the method, and I can only state that after a year's trial on some ninety cases, I have satisfied myself that for certain operations it is unsurpassed by any of the methods now in use.

The underlying principle of intratracheal administration is now well known. Air under pressure, conveying a varying percentage of ether, is supplied to the patient through a catheter passed through the glottis. The catheter reaches to the bifurcation of the trachea, and is of such a size that its diameter is about half that of the glottis: in adults, a No. 22 French catheter is used. The pressure of the air (from 10 to 30 mm. of mercury) is not only sufficient to inflate the lungs, but is capable also of maintaining efficient oxygenation of the blood, since, owing to the constant escape of air allowed at the glottis, the continuous stream of fresh air which takes its place is applied directly at the bifurcation of the trachea. Experimentally it has been shown that, even in the absence of respiration by the injection of curare, or when respiratory movements have been rendered ineffectual by opening both pleural cavities, life may still be maintained by this ingenious method of artificial respiration.

It is obvious, therefore, that for the future development of thoracic surgery, this method of respiration and anæsthetization will undoubtedly play a large part in perfecting the technique of all chest work. Indeed it has already rendered possible the brilliant vascular researches of Carrel, Crile, Guthrie, and others.

It is, however, with regard to its use in general surgical work that I wish more particularly to speak.

The five great advantages are :—

1. The extreme accuracy of the dosage, and the ease with which the percentage of ether vapour may be varied.

2. By the continuous out-going stream at the glottis, the risk of aspiration of blood, mucus, vomit, or pus is entirely obviated, and operations upon the mouth and jaws can therefore be performed without the slightest fear that blood

will be aspirated. In cases of intestinal obstruction, even if the patient vomits, it is impossible for any fluid to reach the trachea against this continuous blast of air.

3. In cases associated with obstruction of the trachea, as for example in goitre operations, the air being applied below the obstruction, no anxiety is experienced even when the enucleation is difficult and the trachea is compressed during operative manipulations.

4. Owing to the fact that the anæsthetist is entirely out of the way of the surgeon, operations about the head and neck are much facilitated. Moreover, in those cases in which the patient lies in a "difficult" position, e.g., for cerebellar, spine, and kidney operations, etc., the administration of the anæsthetic is much simplified.

5. The movements of respiration, though not entirely suspended, are much diminished in extent, and render operations in the upper part of the abdominal cavity easier of performance.

The apparatus which I first made was modelled on that of Elsberg, with the exception that, instead of warming the air current before passing it over the ether, I warmed it subsequently, for I found that the chilling of the current of air by passing it over the ether was liable to produce dew formation with its attendant disadvantages.

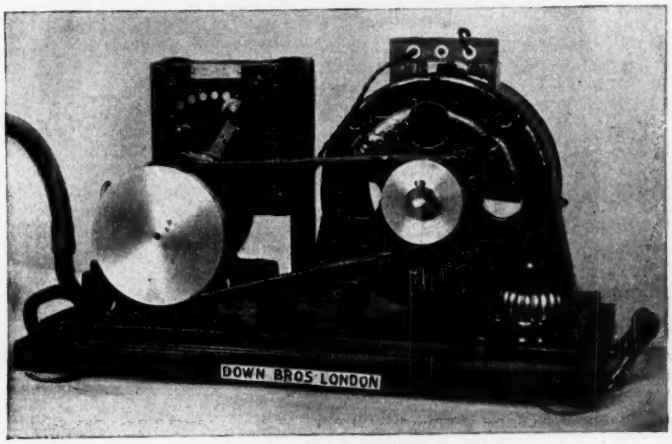


FIG. 55.—THE MOTOR AND BLOWER.

My new apparatus, made by Messrs. Down Bros., London, consists of two parts. The first an electric motor and blower (*Fig.* 55). The motor run from the local electric main must be wired to suit the special voltage. It actuates a small rotary blower which produces the blast of air. By means of a resistance, the speed may be regulated to produce differences in the strength of blast. Should the noise of the motor be disconcerting, the whole of this part of the apparatus may be placed in an adjoining room, or if the electric current be not available, the place of the motor and blower may be taken by a foot-pump. The foot-pump must always be at hand in case of failure of the electric current during the course of an operation.

The blower is connected by means of a stout rubber tube with the second part, or anæsthetic apparatus proper. This portion has been made as light, compact, and portable as possible. The tubing is of one diameter throughout, with all angles rounded to prevent friction. The apparatus consists of four parts: The ether chamber, the warming chamber, the safety valve, and the manometer (*Fig.* 56).

The ether chamber, made of glass, is 12 cm. in diameter, and is fitted with a metal lid having an entry and an exit for the air current, and a third opening for the introduction of ether. In order to " pick up " as much ether as possible, the entry tube is long and dips down into the air space above the ether for about 4 cm. Although it does not reach the surface of the ether, it is possible by this simple means to obtain stronger vapour than if both entry and exit were flush with the lid. The entry and exit tubes are interrupted by taps geared by cog-wheels to a third tap connecting both entry and exit. A percentage of ether vapour varying from zero up to full saturation can thus be obtained by a turn of the handle.

This etherized air is now warmed by passing it through a coil of metal tubing immersed in hot water. To prevent injury to the delicate mucous membrane of the trachea, a moistened piece of gauze is introduced into the circuit.

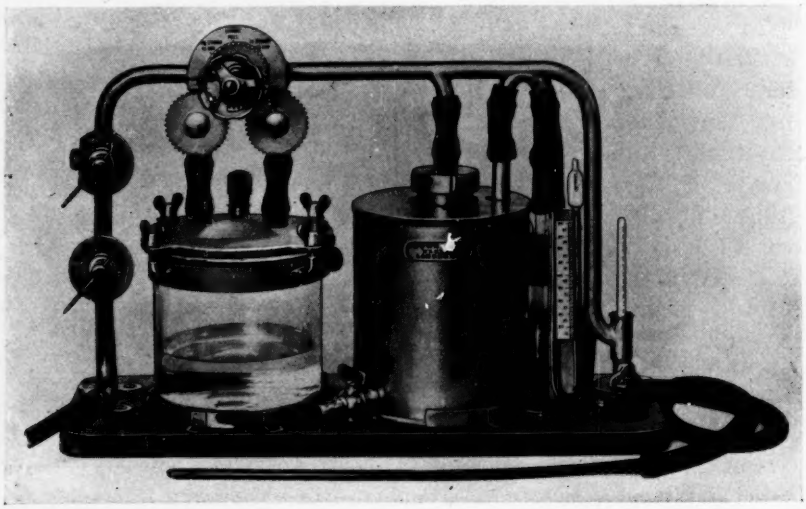


FIG. 56.—THE MODIFIED ANÆSTHETIC APPARATUS.

The safety valve consists of a glass tube which dips into mercury. By this means the pressure of the air in the patient's trachea is not allowed to exceed any pre-arranged pressure. By varying the depth of the tube in the mercury, the instrument can be adjusted to " blow off " at any pressure.

A simple mercury manometer is also placed in the circuit.

There are three taps on this instrument, the first two before the ether chamber, and the third after the manometer. The first tap controls the general pressure of the air as it leaves the blower. The second is a three-way tap, so that, if desired, nitrous oxide gas and oxygen may be administered by this apparatus intratracheally. The third tap (also a three-way tap) enables the anæsthetist to reduce the pressure in the patient's trachea to zero.

A thermometer indicates the temperature of the air current as it leaves the apparatus. There is a slight loss of heat between the instrument and the patient.

The practical points in the management of this method of anæsthesia are as follows :—

The patient is anæsthetized in the ordinary way with ether, and must be well under. This is a very important point, for if the patient is insufficiently anæsthetized it will be difficult to pass the tracheal tube, and trouble may be experienced owing to glottic spasm.

With the head well over the end of the table, a Chevalier Jackson's direct laryngoscope is passed. No attempt should be made to pass the tracheal catheter without seeing the glottis. To try to pass it blindly through an introducer is less satisfactory than this simple procedure under direct vision. With the patient well under, the manœuvre is easy after a little practice.

The tracheal catheter which I use is the ordinary coudé catheter with two side openings. The beak of the instrument is very useful in directing it into the glottis. The catheter is passed down to the bifurcation, i.e., about 26 cm. from the incisor teeth.

The current of air is now directed into the catheter. At first there is some spasm of the glottis, and the pressure inside the trachea is raised by expiratory efforts. This is shown by the fact that the safety valve begins to bubble. Full ether is now turned on, and the current interrupted by opening the third tap every few seconds. The spasm will soon pass off. The percentage of ether is now lessened and the pressure lowered until the patient passes into a state of regular but feeble respiratory movements.

Since the method was first introduced, various figures have been given as to the highest pressure compatible with safety. It is now cited at 15 mm. Hg. An average of 20 mm. will suffice for all general surgical work with the chest unopened.

For the remainder of the anæsthesia, one has merely to vary the percentage of ether according to the patient's condition, and occasionally to interrupt the current and allow the pressure to fall to zero. This gives the right side of the heart and the great veins of the thorax a chance to fill, but I doubt whether this is really necessary if the safety valve is in circuit. In one of my cases, an anæsthetist unfamiliar with the apparatus neglected this occasional reduction of pressure during the performance of an exploratory operation on the brain. There were no ill effects.

When this method was first introduced, it was stated by Meltzer and Auer that it was impossible to kill an animal with the amount of ether that the current of air could take up by merely passing over its surface. This statement they have since corrected, and some of the instruments which have been invented later have a side tube, so that the air current may actually bubble through the ether in order to give a much stronger percentage. I have found, however, that in a single case only was there any difficulty in keeping the patient well under. As a rule, less than " full ether " will serve to maintain efficient anæsthesia, and in the case just mentioned the failure to obtain complete relaxation of the abdominal wall was due to using a tube which was both too long and too narrow between the blower and the ether chamber. I prefer to retain the ether chamber as a " surface carburettor," and to use a larger chamber, rather than to adopt the ingenious but rather more dangerous device of bubbling the air through the ether.

After the operation is over, pure air is passed for a few minutes, and the tube taken out before the current of air is turned off. The patient almost immediately begins to respire with a normal rhythm. This is curious, for one might suppose that here we had conditions likely to give rise to apnœa and acapnia. Theoretically, the increase of the air-pressure, by increasing the partial pressure of the oxygen, would assist in its diffusion into the blood, whilst it would tend at the same time to dam back the outward diffusion of the CO_2. This effect on the CO_2 must, however, be minimal. Whatever the explanation, provided the breathing remains regular and slight in extent, there is no risk of the CO_2 content of the blood becoming reduced to a dangerous amount. Normal breathing is restored almost immediately after the catheter is removed.

In my cases, which comprise operations in all parts of the body, there has been no vomiting during the course of the anæsthetic, and it has occurred but rarely during recovery.

There has been no trouble with the lungs. I have even tried it in a case of chronic bronchitis without any ill effects. I consider that the so-called ether bronchitis is due, not so much to the irritating effect of the ether vapour on the respiratory passages, as to the inspiration of septic saliva. With this method of anæsthesia it is impossible for the salivary secretion to reach the trachea. Chloroform alone, or a mixture of chloroform and ether, have been used intratracheally, but I have had no experience with either of these. Ether has acted perfectly well, and possesses the great advantage of being less toxic. Moreover, it has been determined experimentally that chloroform administered to cats intratracheally caused more damage to the respiratory passages than ether used in the same way.

There is no doubt a great future for the employment of nitrous oxide and oxygen by this method, but up to the present it has received only a limited trial. Cotton and Boothby[1] state that they have succeeded in keeping a cat anæsthetized for sixteen hours by gas and oxygen administered intratracheally with the pleural cavities widely opened. On the discontinuance of the anæsthetic the animal recovered in fifteen minutes, though in a state of exhaustion from its all-night exposure in a cold room. Cotton and Boothby's paper on this subject is an excellent one, and the bibliography up to date.

Practical Points in Technique.—Before any attempt is made to pass the tracheal catheter, the patient must be well anæsthetized. The catheter should be perfectly smooth, in order to avoid injury to the tracheal mucous membrane. To introduce it I use a Chevalier Jackson's instrument with distal illumination. Compression of the catheter by the patient's teeth is prevented by a Smith's gag without the tongue-piece, and the catheter is maintained in position by a small bull-dog forceps fastened to the gag. In operations upon the jaws and mouth in which Smith's gag cannot be employed, I use the Doyen gag. The catheter is fixed to the angle of the mouth by a stitch on the opposite side to the operation. This prevents its displacement and does not interfere with the swabbing.

In operations upon the thyroid gland, in which I think this method of anæsthesia finds its best application, I use a somewhat smaller catheter if the

x-ray photograph indicates marked stenosis of the trachea. Any stridor in the course of the enucleation of the gland is purely expiratory in character, and may be disregarded, inasmuch as air is freely entering the trachea through the catheter.

Safety of the Method.—In my series of cases there has been no fatality referable either to the anæsthetic or its method of administration.

In a recent paper Meltzer[2] gives details of three deaths. In the first case the apparatus used was one which allowed the air to bubble through the ether in the same way as the air is driven through the chloroform in a Junker's inhaler. By a mischance the tubes were connected in reverse order, and liquid ether was forced into the lungs. In the apparatus I have described above, the tubes are not in contact with the ether, and such an accident could not happen. In the second and third fatal cases, the patients died of surgical emphysema and asphyxia due to excessive pressure in the lungs.

These fatalities indicate the necessity, not only for a safety-valve in circuit, but also for the avoidance of all laceration of the mucous membrane during the introduction of the catheter.

I have refrained from employing this method of anæsthesia in cases of empyema, as I have not yet satisfied myself as to the limit of pressure that may safely be borne by a lung softened by disease. Though some healthy individuals can exert an expiratory pressure of 160 mm. Hg, the average highest pressure possible must range about the level of the blood-pressure in the aorta. In one of the fatal cases recorded by Meltzer, the lung burst at a pressure of 120 mm. Hg. In my cases I do not allow a pressure of from 20–30 mm. Hg. to be exceeded. This seems to afford a fair margin of safety.

I have used this method of anæsthesia in the following cases :—

Head and Neck.—Exploration for cerebellar tumour ; exploration for traumatic epilepsy ; excision of upper jaw ; excision of lower jaw ; excision of tongue ; extensive dental extractions ; thyroidectomy ; removal of malignant and tuberculous glands in neck.

Thorax.—Removal of breast.

Abdomen.—Gastroenterostomy ; cholecystostomy and cholecystectomy ; ileo-sigmoidostomy ; appendectomy ; herniæ ; excision of the rectum ; exploration and removal of the kidney.

Limbs.—Loose cartilage of the knee ; amputation of the thigh.

REFERENCES.

[1] *Ann. of Surg.* 1913, Jan.
[2] *Keen's Surgery*, vol. vi, April 1913.

A CRITICISM OF SOME RECENT METHODS OF ANÆSTHESIA.

By FRANCIS E. SHIPWAY, London.

The science of anæsthesia has been characterized within recent years by a most remarkable spirit of progress and a notable dissatisfaction with methods hitherto in use. New ideas succeed one another with great rapidity, fresh methods are being brought forward, old methods are being revived. The percentage system of chloroformization, open ether anæsthesia, the use of morphine and other alkaloids, nasal etherization, intravenous infusion anæsthesia, and intratracheal insufflation are examples of the former; rectal etherization and nitrous oxide-oxygen anæsthesia are examples of the latter. It is worthy of note that most of these innovations and improvements arise from a desire to obtain a system of anæsthesia which will abolish the drawbacks and retain the advantages of ether. Further, that in nearly all of these methods the simplicity of procedure so desirable in the administration of any anæsthetic agent is replaced by an apparently inevitable complexity of apparatus. Some of these methods have been taken permanently into favour; others are as yet on their trial. An attempt is made in the present article to offer a criticism and appreciation of some of the more important; for this purpose it is proposed to discuss—(*I*) *The intravenous infusion of ether;* (*II*) *The intravenous infusion of hedonal;* (*III*) *The intratracheal insufflation of ether;* and (*IV*) *The administration of nitrous oxide and oxygen in major surgery.*

I. INTRAVENOUS ETHER ANÆSTHESIA.

Burckhardt[1] was the first to introduce this method of anæsthetization into clinical work, after experimental study by himself and other workers, notably Ehrmann. He used solutions of ether of various strengths in normal saline, and found that while severe hæmoglobinuria followed the infusion of a 10 per cent solution, excellent results were obtained with a 5 per cent solution. The administration of the drug was intermittent. His success was so striking that numerous other surgeons adopted the method, and at the German Surgical Congress of 1911, Kümmel reported ninety cases, while Hagemann, Wendel, König, and others narrated their experiences. According to Kümmel, the contraindications to its use are arteriosclerosis, myocarditis, and plethora. He found it very convenient for operations about the head and neck, for the prevention of shock, and for the improvement of the condition of exhausted patients about to undergo severe operation. Rood[2] introduced the method into England and has used it with satisfactory results in many cases; but realizing the disadvantages of an intermittent administration and the dangers of thrombosis in and about the cannula, he has devised a technique by which the solution can be injected continuously and in a minutely graduated stream. Schlesinger[3] employs a more safe and simple apparatus; warning is given of

any regurgitation of blood, and the entrance of bubbles of air or ether into the blood-stream is prevented.

The advantages claimed by Rood for the method are many, and it is necessary to discuss them and the disadvantages somewhat fully, in order that a clear idea may be obtained of its usefulness, and of the principles which should guide us in its selection in any given case.

In the indirect or inhalation system of anæsthesia there are certain inherent disadvantages. The choice of drug is limited to highly volatile substances, the vapour of which is of an irritating nature to the mucous membrane of the respiratory tract, so that any pre-existing pulmonary disease may be aggravated by their use, or an acute inflammation of the lining of the tract may be started. The dose entering the blood is influenced by variations in the depth and rate of respiration, and by the existence of such extraneous factors as respiratory and laryngeal spasm, whether caused by the anæsthetic itself or arising from the surgical stimuli of the operation. Further, the amount of the anæsthetic used is in excess of what is actually required, and remains in the system at the end of the administration, putting increased strain on the excretory organs. In infusion anæsthesia, on the other hand, the drug is introduced directly into the blood, and the dose can be cut down to a minimum and accurately measured. The danger of pulmonary irritation is very slight; the spheres of activity of the surgeon and anæsthetist are separated, and operations upon the head, neck, and mouth can be performed without mutual hindrance and embarrassment.

Theoretically then, there is much to be said in favour of this method, and the advantages seem so great that a more extended use of it might be urged. In practice also it has been found to be of considerable value; the type of anæsthesia is excellent, excitement and struggling during induction can be quickly cut short, and the method gives extreme flexibility, so that light or deep anæsthesia can be obtained in a very short time. Consciousness is quickly regained, and after-vomiting is rare. The infusion of the saline is of great benefit to emaciated and desiccated patients, and to those suffering from severe shock or hæmorrhage. It is undoubted that some bad cases are in a better condition at the end of operation than at the beginning. The absence of pulmonary irritation would seem to offer the best chance of recovery to patients with pulmonary tuberculosis who may have to face the ordeal of a severe operation, such as ileosigmoidostomy or colectomy. That the method is preferred by patients who have had experience of inhalation anæsthesia is undoubted. The feeling of suffocation, which is so terrifying to a very nervous subject, is absent, and induction is free from discomfort. The after-condition, both mental and physical, is excellent, and the certainty that a perfect recovery can be assured, in cases where post-anæsthetic vomiting has been a distressing feature on previous occasions, is a very great gain.

The disadvantages of the method are many. Apart from the dangers of sepsis, air embolism, and thrombosis, which can only be avoided by a thorough knowledge of the principles and a complete mastery of the technique, the preparation of the apparatus and of the patient, and sometimes the finding of a vein, demand the expenditure of considerable time and the help of an assistant. Indeed, the preliminaries of the anæsthetization constitute a minor operation in themselves. In some fat subjects the finding of the vein is not easy; in

others the veins of the leg, if the internal saphenous has been chosen, will be found to be thrombosed. The 5 per cent solution originally used has proved to be inadequate. Hæmoglobinuria, sometimes severe, followed the use of a 10 per cent solution, but it has been proved that a 5 per cent solution at the outset can be increased to 10 per cent without danger, or a 6, 7, or 8 per cent solution can be used throughout.

This possibility of variation in the strength of the solution has diminished the necessity for large injections, cut short the induction period, and enabled the administrator to meet the individual needs of any patient. On the other hand, considerable nicety of judgment as to the amount of fluid necessary for the maintenance of adequate anæsthesia, and as to the probable duration of any given operation, is required. It is this danger of excessive infusion and "drowning" of the patient that is one of the most serious objections that can be brought against infusion anæsthesia. The best results will undoubtedly be obtained by the preliminary injection of morphine and scopolamine, either separately or together, and atropine, but the danger is not altogether removed thereby; the decision to use the method must always be largely influenced by this consideration. Some fatalities and many serious pulmonary sequelæ have resulted from the use of large injections. To be within the limits of safety it must be recognized that 3 to 3½ pints is the greatest quantity which it is wise to administer.

Grünbaum[4] has drawn attention to "post-operative drowning," and maintains that the condition of the kidneys and lungs should be carefully investigated beforehand, and that intravenous infusion of saline should be used only to replace fluid lost from the body. He considers that ether is the worst anæsthetic to administer in combination with saline infusion. These conclusions were published before the days of infusion anæsthesia, and have lost some weight in consequence; but the lesson enforced remains true,

Moynihan[5] says that the custom of giving saline infusion to patients suffering from severe shock is not seldom followed by acute œdema of the lungs with frothy expectoration. Veale[6] quotes a case coming under his own observation in which a fatal result occurred. Indeed, the complication has long been recognized; enthusiasm for intravenous etherization has almost buried it in oblivion.

It is further doubtful, in the light of increased experience, whether this method is as advantageous in the surgery of the neck, face, and head as was originally claimed. Many of the patients are vigorous, plethoric men, accustomed to the free use of tobacco and alcohol; they are difficult subjects, and require a large amount of anæsthetic. Further, the bleeding is increased, there is troublesome oozing from the tissues, which continues after the anæsthetic is withdrawn, and the time of operation is unduly prolonged. In operative procedures on the mouth and air-passages, the necessity of removing blood, mucus, etc., and of maintaining a free air-way, diverts the energies of the anæsthetist from the administration, the safety and success of which depend entirely upon his unremitting attention.

That the increased blood-pressure is not without its dangers in other respects is well illustrated by a case which has been reported to me of gastro-jejunostomy for a gastric ulcer which had given rise to a severe hæmorrhage. The patient

was blanched and in a serious condition—apparently a very suitable case for intravenous ether anæsthesia. Bleeding was started afresh by the infusion, and continued during the remainder of the administration, and for some time afterwards.

It is a serious handicap to the value of this method that the moving of a patient from one position to another after the infusion has been started, for example from the dorsal to the lateral position, entails some risk of interruption of the current and shifting of the cannula, with the possible occurrence of thrombosis.

From a consideration of the arguments, the question may well be asked, Is intravenous ether anæsthesia in difficult cases to be preferred to other methods of anæsthetization? It would appear that it is a valuable addition to our anæsthetic methods, with a definite and limited application. The results obtained with open ether in combination with morphine, scopolamine, and atropine, and subcutaneous saline infusion, are so excellent that it is difficult to improve upon them, and much care and judgment are needed in the use of intravenous etherization to equal them.

II. HEDONAL ANÆSTHESIA.

Hedonal, or methyl-propyl-carbinol urethane, is a white crystalline solid, stable at ordinary temperatures. It is slightly soluble in cold water, more soluble in water at 100° F.; it crystallizes out of a saturated solution in fine long needles. Boiling in neutral solutions does not affect its composition. In action it is similar to trional. It is strongly diuretic, and according to Dreser[7] has ten times the hypnotic effect of urethane. Blood-pressure is slightly lowered; respiration is said to be practically unaffected.

Lampsakow[8] ascertained by experiments on dogs and rabbits, that a dose of 0·4 to 0·5 gram per kilo of body weight produced complete general anæsthesia, in which the cardiac and respiratory rates remained regular. The vasomotor centre was paralyzed by toxic doses before the heart stopped beating. Federoff[9] suggested its use in human beings, and reported 530 cases to the German Surgical Association in 1911; no deaths were directly attributable to the drug. Respiratory depression was noted in eight cases, but respiration was soon started again. Jeremitsch[10] failed to procure anæsthesia in two cases out of sixty-five when using the veins of the leg, due to a varicose condition or insufficient size of the vein. Intermittent infusion of a ·75 per cent solution in normal saline was employed.

The method has been introduced into England by C. M. Page,[11] who has used it in a fairly large number of cases. He substitutes continuous infusion for the intermittent administration, and adopts a technique practically similar to that of the intravenous infusion of ether. He claims that hedonal has the following advantages over ether: (1) It is stable, and can be injected sterile and at body temperature; (2) It is excreted by the kidneys and does not irritate the lungs; (3) Being slowly excreted it can maintain anæsthesia with smaller quantities of the solution; (4) It produces complete muscular relaxation; (5) The administration is succeeded by a deep quiet sleep for some hours.

In considering the place that may be given to hedonal in the list of general anæsthetics, regard must be had not only to the method of administration but to

its special peculiarities and properties. The advantages and dangers of the infusion system of anæsthesia have been already discussed in the preceding section, and it is not necessary to point out here any small differences that may exist in the administration of the two drugs. We are chiefly concerned with the peculiarities of hedonal, and sufficient evidence has accumulated to enable a fair judgment to be pronounced of its merits. Hedonal is a powerful hypnotic, and its chief danger lies in the lowering of blood-pressure and depression of the respiratory centre. Cyanosis, therefore, is to be carefully avoided. It is most likely to arise from rapid injection during induction. Page recommends that the solution should be run in at the rate of 100 c.c. per minute. Mennell[12] thinks it better to use a slower rate than this. Cyanosis may also arise during anæsthesia through falling back of the tongue or lower jaw. The dangers attending its onset, or the administration of an overdose, are much increased by the slowness of excretion, and when it is remembered that the exact determination of the depth of anæsthesia at any moment is a matter of some difficulty and calls for considerable experience, it must be admitted that the use of hedonal ought not to be undertaken without a full knowledge of its limitations. Barrington Ward[13] mentions a striking case in which stoppage of respiration was accompanied by the presence of a good colour; no warning had been given. This patient recovered, but in the case of a child, who was subsequently shown to possess marked evidences of status lymphaticus, respiration suddenly failed at the end of the operation, and death resulted. Here again, the colour had been good and the respiration unobstructed. The corneal reflex as a sign of the depth of anæsthesia is valueless. The most important indications are the presence of quiet regular breathing and the persistence of the skin reflex. The latter must always be present and always be kept brisk; this is very inconvenient for the surgeon, as the patient will move violently during the skin incision and whenever the skin edges are touched. Muscular relaxation is at the same time complete. Moynihan[14] speaks very favourably of this advantage in abdominal surgery. The type of anæsthesia is almost perfect if care be exercised to prevent respiratory obstruction. The after-effects, as regards vomiting and shock, are good. Vomiting is probably slightly more frequent than after the intravenous infusion of ether; headache occurs in a small number of cases, and in some patients a period of excitement has been observed during recovery.

A prolonged deep sleep which follows the administration, lasting usually six to twelve hours, and sometimes as long as forty-eight hours, is in the great majority of cases a very distinct disadvantage. In many it is an actual danger. Careful and constant vigilance is demanded of the nurse until consciousness is regained. Food or drugs cannot be given, and the relatives cannot be assured that recovery from the anæsthetic is complete. Upcott and Evans[15] have reported a death following an apparently uncomplicated case; respiration gradually failed some hours after the administration, although the condition of the patient had been considered satisfactory. Veale[16] draws attention to the common occurrence of local pressure effects, i.e., local œdema and blisters, which come on shortly after operation in spite of every precaution, and may develop into bedsores. They are due, he holds, to the effect of slight pressure during profound sleep on tissues, the resistance of which has been lowered by the drug.

The laryngeal reflex is absent for some hours after anæsthesia, and any operative procedure about the mouth or air-passages causing hæmorrhage into them is likely to cause death from the quiet invasion of the trachea and lungs by blood. Barton[17] and Mennell[18] have both recorded cases of this nature.

Hedonal anæsthesia entails a special danger of pulmonary complications and sequelæ. Pulmonary œdema due to large injections is the origin of these, and is followed by septic infection from the mouth during prolonged unconsciousness. Statistics from the Leeds General Infirmary[19] reveal a heavy mortality and a long list of serious sequelæ. In 436 cases there were 44 deaths, as compared with a death-rate of 6·4 per cent for other methods. Of these cases, five died shortly after the administration and had marked œdema of the lungs; in four who died later the same condition was present. Two of these deaths were directly attributed to the drug, which was also a large factor in many of the others. Pneumonia, infarction, thrombosis, and multiple abscesses of the lung also occurred. Injections up to 1200 c.c of the solution are comparatively free from these risks. As the dose of hedonal by mouth is from 1 to 3 grams, the infusion of 1200 c.c. of a ·75 per cent solution cannot be without danger. Increased experience will, of course, enable the anæsthetist to use smaller quantities, but it will be gained at a heavy cost. Hedonal is at least as dangerous as chloroform in its immediate effects, and has a longer list of formidable complications.

Local thrombosis at the site of injection is common if the temperature of the solution is much above blood heat.

Page thinks that hedonal is contraindicated in acute lung disease, general arteriosclerosis, and conditions of cardiac weakness. He recommends it for acute cellulitis of the neck, but it is very doubtful whether the use of a drug which so markedly depresses respiration is not an added source of danger in these cases.

A combination of ether and hedonal has been tried, and although some successful results have been obtained, it is probable that it will not stand the test of time.

Hedonal has so far given the best results in intracranial surgery, and its use is now almost entirely confined to this branch. The mortality is considerably less than that of chloroform or ether, shock can be largely prevented, the absence of vomiting and the prolonged sleep are of great value to the patient, and the nursing of these difficult cases is facilitated.

III. INTRATRACHEAL INSUFFLATION OF ETHER.

The discovery by Meltzer and Auer,[20] in 1909, of the essential principles underlying "continuous respiration without respiratory movements," and of the possibility of procuring anæsthesia at the same time, was the culmination of the work of many years by many investigators. As early as 1667, Robert Hook[21] had demonstrated before the Royal Philosophical Society that the continuous inflation of air by bellows through the trachea of an animal whose chest walls were removed and lungs punctured, was sufficient to keep it alive. "I caused another pair of Bellows to be immediately joined to the first . . . and pricking

all the outer coat of the Lungs . . . this second pair of Bellows was mov'd very quick, whereby the first pair was always kept full and always blowing into the Lungs, by which means the Lungs were always kept very full, and without any motion. . . . This being continued for a pretty while, the Dog, as I expected, lay still, as before, his eyes being all the time very quick, and his Heart beating very regularly. But, upon ceasing the blast and suffering the Lungs to fall and lye still, the Dog would immediately fall into dying convulsive fits: but he, as soon reviv'd again by the renewing the fulness of his Lungs with the constant blast of fresh Air." Hook recognized the possibility of artificial respiration without the necessity of respiratory movements, but his experiments do not seem to have borne much fruit. In 1900, Nagel[22] was able by blowing a continuous current of air through the cavity of the humerus of curarized pigeons to keep them alive for two hours; the air escaped through the trachea. Eight years later, Volhard[23] showed that a small stream of oxygen introduced into the trachea of a curarized dog would prolong life for one to two hours. Death occurred from CO_2 poisoning, and more quickly if air were substituted for oxygen. The pressure of the stream was not sufficient to distend the lungs. His experiments aroused interest; Robinson[24] continued the investigation and nearly succeeded in solving the problem. Using a tracheotomy opening and a stream of oxygen introduced at the bifurcation of the trachea, he was able to maintain life in the presence of almost complete collapse of the lungs; if air were used, he found that the lungs must be kept almost fully inflated. Robinson apparently did not realize the importance of certain conditions, and it was left for Meltzer and Auer to establish the method on a satisfactory basis.

The essential conditions for intratracheal insufflation in the absence of respiratory movements, whether caused by double pneumothorax, the administration of curare, or other means, are that a continuous stream of air shall be introduced under pressure at the bifurcation of the trachea by means of a catheter of sufficient size to fill about one-half of its lumen. The excess of air escapes upwards between the catheter and the tracheal walls. Meltzer and Auer found that the success of their experiments depended upon the catheter being pushed down to the bifurcation; the nearer the point of it reaches the larynx the sooner the death of a curarized animal occurs. Cutting out the dead space is necessary. The real respiration is an exchange of gases between the tidal and alveolar air by diffusion, and the respiratory movements only change the air in the trachea and larger bronchi. A continuous stream of air under pressure inflates the lungs, and supplies oxygen directly to, and removes CO_2 from, the alveoli. "For the to-and-fro type of external respiration is substituted a type of internal respiration."[25] In an animal under the influence of curare with the thorax widely open and intratracheal insufflation proceeding, "the lungs are found more or less distended, of pink colour and completely quiet, while the heart is beating efficiently and regularly."[26] Meltzer has shown that intratracheal insufflation is the most perfect system of artificial respiration. He has resuscitated dogs which had received intravenously twice the fatal dose of strychnine, in whom heart and respiration had stopped for over ten minutes; similarly dogs poisoned with morphine, ether, carbon monoxide, etc. Planchu[27] has been successful with badly asphyxiated new-born infants. It would seem that the method has a great future in medicine for keeping patients alive in whom from various

reasons, e.g., morphine poisoning, respiration has failed; it was in a case of this description that the method was first applied to a human being.[28]

If ether be added to the air current, anæsthesia can be maintained with perfect safety. Carrel has adopted the method in his valuable researches, finding it simple and very safe, while Meltzer, Crile, and others have been able to remove one or more lobes of the lung and perform other remarkable intrathoracic operations. Cotton and Boothby[29] have used gas and oxygen in some of their experiments, and have succeeded in keeping a cat alive for sixteen hours under this anæsthetic, with both pleural cavities widely open. The cat quickly recovered on the anæsthetic being withdrawn.

It is a positive pressure method. As the apparatus can be made more cheaply, and is less cumbersome, more adaptable and simpler than the negative and positive pressure cabinets and masks of Sauerbruch, Brauer, Meyer, Robinson, and others, it must eventually replace them in intrathoracic surgery; besides this, they depend for the maintenance of life upon the efficiency of the respiratory mechanism of the patient. Intratracheal insufflation is independent of this and gives a greater margin of safety. Elsberg[30] has devised an apparatus by which warmed, moistened, and etherized air is supplied in a continuous stream under a pressure of 10 to 40 mm. Hg. The stream is broken at intervals to allow the lungs to collapse and the great veins of the thorax to fill; these interruptions act also as a sort of artificial respiration by which, at the moment of deflation, any excess of CO_2 is driven out, and at the resumption of insufflation fresh air is pumped into the lungs. Others have followed Elsberg, including Janeway,[31] Ehrenfried,[32] and Cotton and Boothby. A short article has been published by Kelly,[33] who demonstrated the method with a modified Elsberg apparatus at the Annual Meeting of the British Medical Association in July, 1912, and later on kindly gave me the opportunity of seeing it at work. Gask and Boyle[34] speak well of the method; they use a more simple apparatus worked by a foot bellows.

In addition to its use in intrathoracic surgery, intratracheal insufflation anæsthesia possesses certain advantages over all other methods.

1. A free and unobstructed air-way is secured. The first cardinal principle of surgical anæsthesia is thus fulfilled, and it is probably the most valuable asset of this method in general surgery (as opposed to its special advantages in intrathoracic surgery) that at all times, during any operative procedure, there is constant and complete oxygenation. Obstruction of the upper air-passages, whether due to falling back of the lower jaw and tongue, retraction of the tongue, or masseteric or laryngeal spasm, is abolished. Intermittent anoxæmia is eliminated. Respiration remains quiet, very light and regular, or is sometimes suspended. It is not necessary completely to abolish respiratory movements, which usually continue with a frequency and amplitude that depend upon the depth of anæsthesia and the velocity of the air-stream. The method is therefore of great value in goitre cases, dissection of glands of the neck, and other operations which interfere with respiration.

A most striking illustration of this was recently afforded me in an operation undertaken for the relief of obstruction caused by a large adenoma of the thyroid in a muscular man of middle age, whose larynx was pushed over to the left side of the neck, and who had had several attacks of urgent dyspnœa. A preliminary

injection of $\frac{1}{6}$ gr. of morphine sulphate and $\frac{1}{100}$ gr. of atropine sulphate was followed by induction with C_2E_3; some excitement and struggling ensued, with spasm of the jaws and increasing cyanosis. The mouth was opened by a gag (previously inserted), and as soon as a moderately deep anæsthesia had been obtained, the catheter (23 F). was passed by direct vision. Spasm very quickly passed off, the colour became a healthy pink, a light and uninterrupted anæsthesia was maintained, and the operation was completed without the least anxiety to the surgeon or myself.

2. Even and uniform administration of the minimum amount of anæsthetic is possible. Recovery is quick, after-vomiting is rare, and very slight when it does occur, and post-operative shock is much diminished. This is one of the most noticeable benefits of the method. Owing to the absence of cyanosis and the constant oxygenation supplied by a mechanical system which "breathes the patient," circulation and respiration are relieved of much strain. The condition of patients after severe operations is so unusually good, especially of patients whose factor of safety has been lowered by sepsis, trauma, or hæmorrhage, in whom a very light ether anæsthesia may be indicated, that it is doubtful whether in them gas and oxygen anæsthesia has any marked advantage.

3. As the excess of air caused by the insufflation escapes between the catheter and the trachea, creating a strong upward draught, no blood, mucus, septic material, or vomit can trickle down or be inhaled into the lungs. In mouth, jaw, and tongue operations, or any operation which causes bleeding into the air-passages, the method is superior to all others; anæsthesia is uninterrupted, blood and mucus are blown up into the mouth; none is swallowed, and moreover, inspiration is so very slight, and of less duration than expiration, that there is no risk of septic pneumonia from aspiration of infective material. Vomiting in these cases is almost always absent. Cases of intestinal obstruction with vomiting are best anæsthetized by this method.

4. In operations about the head and neck the anæsthetist is out of the way, and the field can be kept sterile. Dissection in the neck is facilitated by the quiet character of the respiratory movements.

5. Efficient ventilation of the lungs can be obtained with the patient lying in the lateral and prone positions.

6. The extreme flexibility of the method, and the light respiration, are of value in abdominal surgery, especially of the stomach and gall-bladder. Exploration of, and severe traction upon, the abdominal viscera are not followed by the reflex respiratory phenomena which occur under, and complicate, other forms of anæsthesia. This must also help to diminish shock.

The appearance of the patient is one of quiet sleep, with a pink colour and good pulse; the type of anæsthesia has been well described by Stiles[35] as "the simplest, smoothest, and most delightful" he had ever seen. An experience of 120 cases has convinced me that it is of great value, and a notable advance in anæsthesia. As the result of many experiments I have modified Kelly's apparatus in some directions, with the object of making it smaller and more compact, and capable of giving a stronger vapour. This is effected by bubbling all or part of the air through the ether, and is especially useful when the ether supply is running low and it is not convenient to refill the chamber. Further, the delivery pipe from the heating chamber has been considerably shortened by

a rearrangement of parts; it is cut down to the minimum length and becomes quickly warmed up, so that the loss of heat between the apparatus and the patient has been reduced to about 25° F. In the passage of the air-ether mixture along metal tubing and 3 ft. of rubber tubing, this loss is so considerable that unless the former is made as short as possible it is practically impossible to deliver the vapour at body temperature. Some authorities attach little or no importance to this question, but it must be admitted that in this method of anæsthesia the natural warming influence of the upper respiratory tract is cut out, and the continuous insufflation of a comparatively cold stream of air-ether vapour must result in the continuous abstraction of heat from the body.

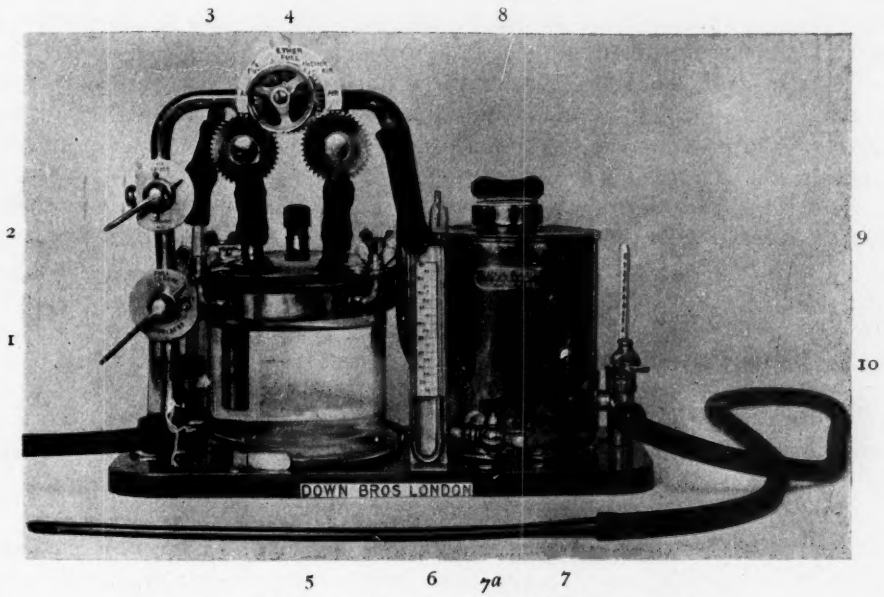


FIG. 57.—APPARATUS FOR INTRATRACHEAL INSUFFLATION.

1. Pressure regulator.
2. Oxygen inlet.
3. Mercury safety valve.
4. Automatic arrangement for passing any desired amount of air over ether.
5. Ether bottle, with arrangement for passing any desired amount of air through ether if required.
6. Mercurial manometer.
7 and 7a. Hot-water tank with emptying tap.
8. Chamber for moistening air current.
9. Thermometer.
10. Tap to lower pressure when required, and connection for tubing.

Size: 15 × 6½ × 12¼ in. high.

The introduction of the catheter is the only difficulty. After a few attempts at indirect catheterization, I have found the best plan to be to cocainize the pharynx and epiglottic region generally with a 5 per cent solution during induction, and to pass the catheter by direct vision. The cords can be clearly seen and the catheter inserted sterile, without damage to the larynx. It is an easy procedure in the great majority of patients. Hill's laryngeal endoscope, distally illuminated, and with a detachable sterilizable shield to protect the lamp, is very useful. A small pocket battery can be attached.

The size of the catheter varies slightly in individual patients, but a little experience will soon guide the anæsthetist in his selection. Direct laryngoscopy

is a valuable help. Speaking generally, 22 F. is suitable for adults, 18 to 21 F. for young girls and boys, and adolescents. Apart from age and sex (the larynx in women is slightly smaller than in men), the governing factor is the depth of anæsthesia, that is to say, the degree of abduction of the cords, required in any given operation. While a 22 F. would give an excellent result in a tongue case, an abdominal operation in the same patient would require a larger size. It is not always possible to obtain deep anæsthesia with a 22 F. in this class of operation on an adult man, and in one or two instances a change to a 23 or 24 has at once given the desired result. I was not aware of this point at first, and found that glottic spasm with prolonged straining expiration and high pressure occurred when a 22 F. was used. Cotton and Boothby[36] recommend 23 F. for all adults, Peck[37] 24 F.; the latter is, I think, too big, and requires unnecessarily deep anæsthesia to avoid cyanosis.

The catheter should be marked at 26 cm. from the tip. This represents the average length of the male trachea, according to Brüning. In women, Brüning gives it as 23 cm., so that allowance must be made for this difference. In children it is considerably shorter.

The spasm of the glottis and cough which often follow insertion of the catheter are not harmful, and give no anxiety provided there is a safety valve in the circuit. It should be set to blow off at 20 mm. Hg. Spasm may arise later under very light anæsthesia as the result of strong surgical stimuli. It is best overcome in all cases by a gradual increase in the strength of the ether vapour. The pressure reading of the manometer depends partly upon the velocity of the air-stream, partly upon the resistance of the apparatus and the size of the catheter. With a 23 F. catheter the pressure reading is usually 12 to 14 mm. Hg, with a 22 F. or 21 F. much higher. It is therefore not an accurate indication of the intratracheal pressure. Eisenbrey[38] found in his experiments that doubling the pressure from 20 mm. to 40 mm. Hg only raised the intratracheal pressure from 1·4 to 1·8 mm. Hg.

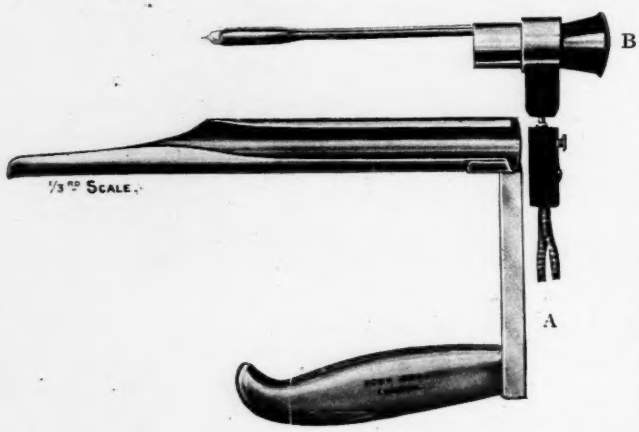


FIG. 58.—HILL'S LARYNGEAL ENDOSCOPE.

A. Hill's slotted spatula.
B. Electric light with detachable oxidized sterilizable metal sheath, guarding those parts which cannot be boiled.

The subsequent conduct of the anæsthesia follows the ordinary lines. It can be kept, however, much lighter, especially if narcotics have been administered previously, as the dose can be accurately regulated. By turning the pointer to "air" towards the finish of the operation, the patient can be rapidly brought to semi-consciousness, even after a long administration. The apparatus then acts as an artificial respiration, and advantage of this knowledge can be taken at any time during anæsthesia should unfavourable signs present themselves.

If intratracheal insufflation is to be generally adopted and assume its right place in anæsthesia, some knowledge must be available of the incidence and severity of complications and sequelæ. It may be said at once that these are singularly few and unimportant. Pharyngitis occurred in three of my earlier cases from unskilful handling of the laryngoscopic spatula. It was of slight degree. There has been one case of mild laryngitis. Peck has not met with it in 216 cases. Robinson,[39] who speaks very highly of the method in a valuable article, notes one case (due to rough catheterization) in 1402 administrations collected from various sources. He refers to a "scrapy" sensation in some patients, probably tracheal in origin. I have met with it in some cases; it is so slight a discomfort that patients do not themselves complain of it, and is of short duration. It is possibly due in part to the actual contact of the ether vapour with the mucous membrane, and can be avoided by keeping the lateral outlet of the catheter uppermost.

Bronchitis and pneumonia, according to most observers, are rare. The factors at play in post-anæsthetic pulmonary sequelæ are so complex that it is difficult to estimate their value. They are certainly more prominent in abdominal operations (to which these sequelæ are almost entirely confined), especially of the upper abdominal viscera, in which their frequency is, according to Pasteur,[40] 12·59 per cent. He attributes to the anæsthetic a very secondary rôle. Excessive mucus secretion, deep inspiratory efforts, and reflex inhibition of the diaphragm are important causal agents, aided by the absence of voluntary efforts to clear the lungs during the recovery period. Doubtless many are cases of aspiration bronchopneumonia. Inasmuch as atropine is always given in intratracheal insufflation, which is further characterized by complete freedom from respiratory obstruction and cyanosis, and any mucus that exists in the mouth or air-passages is immediately blown up by the air-current, excessive mucus secretion never occurs. Further, inspiration is very slight in depth. Reflex inhibition, which is probably the starting-point of all post-anæsthetic pulmonary lesions, cannot of course be abolished, and it remains to be seen whether these lesions are more frequent, or, as appears more likely, less common, after the use of this method. Robinson's statistics give eight cases of pneumonia; unfortunately the nature of the operation is not always stated, but one case followed laryngectomy and one thoracotomy for œsophageal carcinoma. In two prostatectomies in my series, in patients aged seventy and seventy-eight years respectively, no trace of lung trouble occurred; two cases of acute bronchitis and one of bronchopneumonia followed the operation of gastrojejunostomy. After operations on other parts of the body, many of them of an hour and upwards, on patients ranging in age from twelve to seventy-two years, recovery has been uninterrupted. This was also the case in six operations for carcinoma of the tongue and mouth in patients whose average age was sixty-eight years; one of these had chronic bronchitis beforehand, which was not in any way aggravated by the anæsthetic. I am inclined to think that in my earlier cases the air was too dry, and acted as an irritant to the mucous membrane of the respiratory tract. This has been remedied by the replacing of the moist gauze in the circuit by a small test-tube containing water, into which a wick is placed.

Rigidity cannot be overcome in all cases, but there is a certain class of patient in whom abdominal interference always calls forth this difficulty under

inhalation anæsthesia. Much of it is purely mechanical, due to the formation of the chest; in two cases of this type, chloroform was substituted for the insufflation and pushed to a very deep stage without any appreciable improvement. Intratracheal insufflation produces in the vast majority of cases conditions almost similar to those of spinal anæsthesia. When rigidity is present, there is no straining, no protrusion of gut, but the belly walls are motionless and taut. The explanation seems to be that whereas in inhalation anæsthesia, respiration is chiefly diaphragmatic, and the abdominal muscles take an active part in expiration, in insufflation anæsthesia the slight distention of the chest and the descent of the diaphragm due to the positive intrathoracic pressure keep the recti and the other muscles continuously on the stretch.

The cases in which I have used the method include goitre operations, gland dissections and other neck cases, enucleation of tonsils, and several cases of epithelioma of jaw, lip, tongue, tonsils, and floor of mouth, besides many abdominal operations. It has also been used in other mouth cases, parotid and face operations, œsophagoscopies, intralaryngeal operations, and in two instances the catheter has been inserted through a tracheotomy wound, the latter having been made for examination of larynx and removal of portions of growth. The catheter does not interfere with the operator, nor has he been hampered in any case by difficulties of respiration; while all anxiety as to inhalation of blood, mucus, etc., is abolished.

The cost of the outfit and the noise of the motor and blower have been put forward as objections to the method. The former has been already reduced, and increasing experience on the part of the manufacturers will soon provide a cheap and efficient apparatus. A foot-bellows can replace the electric motor and blower, although for hospital practice, and whenever possible, the latter are more convenient, are simple to run, and are now made quite noiseless. A more serious objection is the passing of the catheter; but I am convinced that if cocainization of the pharynx and direct laryngoscopy be practised, the operator will rapidly acquire the necessary skill and feel confident of successful intubation in each patient.

Gas and oxygen anæsthesia by this method has been practised in a few cases, but the expenditure must be very great unless a little ether is added; even then, the cost is hardly to be justified.

Intratracheal insufflation has so many good points that it deserves an extended trial. It is the experience of all who use the method that it should be more generally adopted, and when the natural reluctance to learn new methods and acquire a new technique, which at the first sight appears complicated and difficult, has been gradually overcome, there will accumulate sufficient material for a correct estimate of its merits and of indications for its use.

IV. NITROUS OXIDE AND OXYGEN IN MAJOR SURGERY.

For many years the use of these agents has been confined in this country to minor surgery, and a few selected cases of major operative procedures. The limitations of the method have long been recognized, and the indications for its selection laid down, as the result of much experimental and clinical work by Sir Frederic Hewitt. The views advocated by him and the unchallenged position

of open methods of administration of ether have been generally accepted until recently, when, owing probably to an increased interest in anæsthesia, the researches of Crile, and the work of the physiologists, fresh attempts have been made, with some considerable degree of success, in the endeavour to improve upon former ideas and diminish the difficulties of the administration of what is undoubtedly a very valuable anæsthetic agent.

Nitrous oxide has many advantages over chloroform and ether. It is the safest of all anæsthetics, the most pleasant to inhale, and the most rapid in abolishing consciousness. It is the least irritating of any anæsthetic agent to the mucous membranes and to the excretory organs, and causes little or no damage to central nerve cells. Crile has pointed out that, owing to its comparative non-toxicity and its rapid elimination from the body, the value of nitrous oxide in the prevention of shock is three to four times greater than that of ether. Further, that assuming the truth of the view that shock is due to exhaustion of the vasomotor centre, and that nitrous oxide limits oxidation in brain tissue, it may be inferred that its use will prevent the brain cells from making an excessive expenditure of energy.[41] The school of Yandell Henderson[42] has advanced the view that shock is due to acapnia or diminished CO_2 in the blood and tissues resulting from hyperpnœa, or from loss of CO_2 by evaporation from the surface of exposed viscera. Shock then may, according to Henderson, be diminished or prevented by the administration of nitrous oxide with a certain amount of re-breathing of the gas, which compensates this loss of CO_2 and conserves its normal content in the blood. In addition to this advantage conferred by re-breathing, it has been shown to have facilitated in other ways, which will be subsequently discussed, the administration of nitrous oxide and oxygen.

After-effects, both gastric and pulmonary, are usually slight, so that it is claimed that these gases can be given successfully, and with good results, in cases where it is especially desired to avoid nausea, and in acute bronchitis and other grave lung affections. That this system of anæsthesia has not been more widely and generally practised in this country, in spite of the many good points in its favour, is not a matter for wonder when we come to a consideration of the difficulties of the administration, the cumbersome and elaborate nature of the apparatus, the expense of the gases, the uncertainty of having a sufficient supply at hand, and the imperfect results so frequently obtained even by experienced anæsthetists. There is no method which demands a higher degree of skill, a wider experience in the selection of cases, and a more unwearying attention to minute details. Hitherto the apparatus chiefly in use in this country has been that of Hewitt. In view of recent research and accumulated clinical material it would seem, however, that certain improvements or alterations in this apparatus can be made, with the object of securing economy of the gases and a more even, profound, and safe anæsthesia. Much of this work has been done in America, where the enthusiastic advocacy of Crile, Teter,[43] and others, combined with the disillusion of many who had hoped to find in ether the ideal anæsthetic, have led to the extensive employment of nitrous oxide and oxygen in major surgery. Crile uses it almost as a routine. Teter, one of the early pioneers, has recorded over 10,000 administrations in general and oral surgery, in cases lasting from a few minutes to three to four hours.

In a recent article, Teter[44] refers to the difficulties and limitations, and

discusses the means by which they may be partially or wholly overcome. These include re-breathing, the addition of ether, warming the gases, and their delivery at a slightly increased intrapulmonary pressure. He was induced originally to adopt the principle of re-breathing in order to reduce the expenditure of nitrous oxide during long administrations. Gatch had previously advocated this plan. Supported by the results of Gatch's experience, the work of Haldane and others on CO_2 metabolism, and the interesting researches of Henderson on acapnia, he has been able to defend the retention of re-breathing on clinical and scientific grounds. By reason of the power of CO_2 to stimulate the respiratory centre, the increased depth and rate of breathing lead to an increased absorption of nitrous oxide, deeper anæsthesia is obtained, and economy of the gases, especially of oxygen, is effected. Further, the CO_2 content of the blood is maintained, and acapnia prevented.

In a certain proportion of cases the addition of ether is necessary in order to supplement the anæsthetic property of nitrous oxide. What this proportion is depends partly upon the demands and forbearance of the surgeon, partly upon the skill, or rather predilections, of the anæsthetist. Teter uses it in 20 to 25 per cent of his general work; Flemming[45] describes a method of alternate administrations of gas and ether. Page,[46] who has recently published some successful results with Teter's apparatus, prefers to add ether in 66 per cent of his cases. He has substituted a Clover's inhaler for the ether arrangement in this model, as the latter did not give a sufficiently concentrated vapour. The quantity of ether used is not large, and varies with different individuals. In some it is only used for induction, in others during the handling of sensitive structures, in others again throughout the whole administration.

It is claimed that the administration of nitrous oxide and oxygen with small quantities of ether gives better results both during and after anæsthesia than any other system.

These two innovations, viz., the adoption of re-breathing and the addition of ether, are the chief departures from the principles, hitherto universally accepted, of the administration of nitrous oxide and oxygen in general surgery. While their employment has been generally recognized in the United States, and they have obtained some support in this country, they lay themselves open to criticism. The re-introduction of the principle of re-breathing is completely at variance with the open methods recently practised, and can only be justified if it can be shown that it is not only a beneficial but a harmless procedure. There is a real danger that the movement now in progress in America to substitute closed for open methods, will produce some unforeseen results. The discovery of open ether was one of the most notable of recent advances in anæsthesia, and any teaching which weakens the position now attained must be deplored. The origin of the attempts being made to re-establish closed methods from which the disadvantages are to be abolished lies partly in adherence given to all the conclusions of the school of acapnia, but chiefly in the desire to undertake work with nitrous oxide-oxygen anæsthesia for which it is not really suited. The routine use of these gases in major surgery of all kinds has strongly emphasized their limitations. Re-breathing has helped to widen their field of usefulness, but has at the same time introduced some grave disadvantages. The chief and most important of these is cyanosis. This is often present, and adds an element

of danger during a protracted administration. Probably some of the unexplained fatalities have been due to its influence in bringing about, especially in weakly or difficult subjects, impeded pulmonary circulation and failure of the right side of the heart. Gatch, and Cotton and Boothby[47] say that any degree of asphyxia is harmful and must necessitate the abandonment of the method. Crile recognizes the frequent occurrence of venous congestion as an objection to nitrous oxide-oxygen anæsthesia. Teter maintains that a slight degree is always present unless much ether is added; he does not, however, consider it objectionable. A smooth anæsthesia with an absence of any asphyxial element is difficult to ensure, especially if re-breathing is practised; moreover, if sufficient oxygen be given to avoid asphyxia, retching or vomiting may suddenly occur. Whether absence of cyanosis, if re-breathing be allowed, is compatible with the maintenance of the CO_2 content of the blood and tissues, is open to considerable doubt.

The addition of ether, even in small quantities, puts a very different complexion on nitrous oxide-oxygen anæsthesia. A method which calls for, or permits the use of, ether in so high a proportion of cases as 66 per cent, many of which were presumably of sufficient gravity to necessitate the administration of these gases, should be more accurately termed nitrous oxide-oxygen-ether anæsthesia. In any attempts to institute comparisons of the safety and freedom from after-effects of nitrous oxide and oxygen with other anæsthetics, a sharp distinction must be drawn between those cases in which ether has been used and those in which this drug has not been added. Statistics which do not take this difference into account are of little value.

The re-breathing of ether minimizes most of the special advantages, e.g., non-toxicity and absence of after-effects, which are claimed for nitrous oxide. The temptation to resort to ether to overcome rigidity or other inconvenient reflexes is too strong to be resisted, and although it is maintained that a small quantity will rapidly produce the desired result, the re-breathing factor adds greatly to its toxic effects. Vomiting is met with in 17 per cent of these cases; the return to consciousness is also delayed. It is very doubtful whether this method has such preponderating advantages over others in difficult or grave cases that it can replace them; its disadvantages constitute too heavy a handicap. In the remainder of this discussion it must be assumed that we are dealing with pure nitrous oxide-oxygen anæsthesia.

Warming of the gases is said to shorten induction, give a safer and deeper anæsthesia, and produce a quicker recovery. Gwathmey,[48] from the result of many experiments, strongly supports this contention.

A slight increase in the intrapulmonary pressure helps the administration. A more even and deep anæsthesia results. Caution, however, must be exercised. While, on the one hand, advantage may be taken of this device in a difficult case, embarrassed breathing and a true nitrous oxide toxæmia may, on the other hand, rapidly follow its injudicious use. This condition is characterized by laboured respiration with an accentuated expiratory phase, and may occur without any evidence of an asphyxial element. In some patients there is a tendency to the rapid development of pallor and respiratory failure, due probably to acapnia. Alarming states[49] sometimes come on with rapidity; excessive re-breathing is partly responsible for some of them.

Rigidity frequently cannot be abolished under nitrous oxide and oxygen anæsthesia. The surgeon must either accustom himself to less perfect conditions and acquire a more delicate manipulation if he wishes to avoid inconvenient reflexes, or use a considerable amount of force to overcome them. Crile admits this objection, upon which considerable stress was also laid at the annual meeting of the American Association of Obstetricians and Gynæcologists, 1912,[50] Skeel asserting that nitrous oxide-oxygen anæsthesia is " neither the most comfortable nor the safest " in the majority of abdominal operations. He maintains that it is not possible to do the work efficiently owing to the rigidity and protrusion of gut, and that the stimulating effect of the oxygen or the CO_2 during a long administration, is often followed, on the withdrawal of the anæsthetic, by severe shock. Skeel thinks that the chief indications for its use are pulmonary and renal affections and conditions of great feebleness. Other speakers urged the disadvantages of the method, and the dangers attending its use. Freeman Allen[49] raises doubts as to its complete safety in grave conditions, and quotes Bennett in support of this opinion. Many fatalities have been reported ; many are unrecorded.

Although it was at one time hoped that nausea and vomiting would be slight and infrequent, the use of this method has been a little disappointing in this respect. Vomiting is occasionally persistent, and patients who have suffered much distress and discomfort after chloroform or ether anæsthesia have undergone a similar experience after the administration of nitrous oxide and oxygen. As a rule, however, vomiting is not frequent ; if the patient has been properly prepared, recovery is attended with little gastric disturbance. Nausea not uncommonly occurs. Severe headache is not unusual, especially if much rebreathing has been practised. The rapid return to consciousness and acute pain is a drawback which may necessitate the injection of a narcotic ; in many patients the preliminary injection will secure freedom from pain and an interval of sleep.

The limitations of the method depend very much on the skill of the anæsthetist and his selective ability, but, speaking generally, it may be said that it is the best anæsthetic for operations upon diabetics, and for patients suffering from extreme conditions of trauma, hæmorrhage, or sepsis, where it is necessary to avoid, as far as possible, toxic effects. Ether should not be used in these cases, or the advantages of nitrous oxide and oxygen are lost. Severe pulmonary and renal affections, and short operations on fastidious and highly sensitive patients who wish to be spared unpleasant after-effects, may call for the use of this method. Bearded and edentulous patients are difficult subjects. Contra-indications are the existence of plethora, obesity, alcoholism, excessive use of tobacco, an excitable and neurotic temperament, or any condition which calls for the exhibition of a large dose of any general anæsthetic. Special contra-indications are a high degree of emphysema and of arteriosclerosis with cardiac degeneration. Young children should not be anæsthetized with nitrous oxide and oxygen, nor should it be used in any condition of respiratory obstruction.

In conclusion, then, nitrous oxide and oxygen anæsthesia has a limited field of usefulness. It has some distinct advantages, many disadvantages, and certain dangers. All of these must be recognized and given their proper proportions, if a valuable method is not to be brought into discredit by misuse.

REFERENCES.

1 *Münch. med. Woch.*, 1910, i, 361.
2 *Brit. Med. Jour.*, 1911, ii, 974.
3 *Guy's Hosp. Gaz.*, May 25, 1912.
4 *Brit. Med. Jour.*, 1911, ii, 1281.
5 *Abdominal Operations.*
6 *Brit. Med. Jour.*, 1912, ii, 347.
7 *Natur. forsch. Versamml.*, Munich, 1899.
8 *Arch. f. exp. Path. v. Pharm.*, 1908, supp., Band 317.
9 *Verhandl. d. Deutsch. Gen. Chir.*, 1911, ii, 222.
10 *Deutschr. Zeitschr. fur Chir.*, 1911, 108, 553.
11 *Lancet*, Mar. 23, 1912, 794 ; 1912, i, 1258.
12 *Ibid*, Nov. 9, 1912, ii, 1297.
13 *Brit. Jour. Child. Dis.*, 1913, 17.
14 *Lancet*, 1912, i, 1631.
15 *Ibid.*, 1912, i, 1568.
16 *Loc. cit.*
17 *Proc. Roy. Soc. Med.*, 1912, vi, No. 2.
18 *Ibid.*
19 *Lancet*, Nov. 9, 1912, 1299.
20 *Jour. Exp. Med.*, 1909, xi, 622.
21 *Philos. Trans.*, ii, 539.
22 *Centralb. f. Physiol.*, 1900, xiv, 238.
23 *Munch. med. Woch.*, 1908.
24 *Jour. Amer. Med. Assoc.*, li, 803.
25 *Surg. Gyn. and Obst.*, Nov., 1910, 482.
26 *New York Med. Rec.*, March 19, 1910, 478.
27 *Amer. Jour. Dis. Child.*, Jan., 1912.
28 *New York Med. Rec.*, March 19, 1910, 495.
29 *Ann. Surg.*, Jan., 1913, 43.
30 *Vide* 26 and 28, also articles in *Ann. Surg.*, 1910 and 1911.
31 *Ann. Surg.*, Aug., 1912, 328.
32 *Bost. Med. and Surg. Jour.*, April 13, 1911, 532.
33 *Brit. Med. Jour.*, July 20, 1912, 112.
34 *Proc. Roy. Soc. Med.*, 1912, Vol. vi, No. 2.
35 *Surg. Gyn. and Obst.*, Aug., 1911, 222.
36 *Loc. cit.*
37 *Ann. Surg.*, July, 1912, 192.
38 *Surg. Gyn. and Obst.*, Dec., 1912, 714.
39 *Ibid*, March, 1913, 296.
40 *Lancet*, May 20, 1911, 1329.
41 *Surg. Gyn. and Obst.*, Aug., 1911, 170.
42 *Amer. Jour. Physiol.*, Feb. 1908, also papers in 1909, 1910, and 1911.
43 *Jour. Amer. Med. Assoc.*, 1909, 448.
44 *Ibid.*, Nov. 23, 1912, 1849.
45 *Proc. Roy. Soc. Med.*, 1910, iv, No. 2.
46 *Ibid.*, 1913, vi, No. 5.
47 *Surg. Gyn. and Obst.*, Feb., 1912, 195.
48 *New York Med. Jour.*, June 1, 1912, 1130.
49 *Jour. Amer. Med. Assoc.*, Feb. 10, 1912, 395.
50 *Amer. Jour. Obst. and Gyn.*, 1913, 102.

THE NATURE OF SURGICAL SHOCK.

A CRITICAL REVIEW OF CURRENT THEORIES, TOGETHER WITH SOME ORIGINAL OBSERVATIONS ON THE CARBON DIOXIDE CONTENT OF THE BLOOD IN OPERATION CASES.

By A. RENDLE SHORT, Bristol.

It is remarkable how interest in this important subject appears to be confined, if we may judge by the literature, to England and America, and it must be admitted that the bulk of the contributions to our knowledge concerning surgical shock come from the latter country. In England, the work of Crile, confirmed and expounded by Mummery, has almost become the settled article of our surgical creed, in spite of the powerful criticisms of Malcolm, based on clinical experience. The fundamentally important researches of Yandell Henderson on acapnia and shock have not received adequate attention.

The principal theories held with regard to the essential nature of shock are the following :—

1. *The Crile-Mummery theory*, that shock is due to exhaustion of the vasomotor centres in the medulla and cord.

2. *The Yandell Henderson theory*, that shock is due to acapnia, i.e., reduction of carbon dioxide in the blood in consequence of the excessive breathing reflexly induced by painful stimuli.

3. *The Boise theory*, that shock is due to cardiac spasm.

4. *The Meltzer theory*, that the injury leads to inhibition of the functions of all the organs, beginning with the less vital, and spreading to the more vital.

In addition to the formal theories set forth by the above writers, we have the following observations to take into account : the contraction of the arteries so much insisted on by Malcolm in England and by Seelig and Lyon in America ; the concentration of the blood described by Sherrington, by Roy and Cobbett, and other observers ; the disappearance of the chromaffine matter in the cells of the medulla of the suprarenal glands, to which attention has been called by Bainbridge and Parkinson ; and the changes in the nerve cells of the brain described by Dolley and Crile.

Having now collected the various opinions and researches which claim a hearing, we proceed to examine some of them in more detail.

1. **The Crile-Mummery Theory of Exhaustion of the Vasomotor Centre.**—This theory is too well known to call for an extended notice. It is claimed that painful stimuli give rise first to a rise of blood-pressure from excitation of the pressor afferent nerves acting reflexly through the vasomotor centre, followed by a fall of blood-pressure from exhaustion of the centre. In some cases, apparently, there are only depressor nerves present, and the blood-pressure falls without any preliminary rise, as when the testes are crushed (Crile). The

most characteristic feature of shock is the fall of the blood-pressure. This cannot be due to failure of the heart, because it occurs even after section of the vagi or injection of atropine, which would block reflex vagus inhibition; also it may occur if the sympathetic innervation of the heart is abolished by cutting out the stellate ganglia. Injection of the medulla with cocaine causes a great fall of blood-pressure by paralyzing the main vasomotor centre, and after this, stimulation of peripheral nerves does not alter the blood-pressure reflexly.

In man, the fall of blood-pressure has been observed by very many workers during the progress of severe operations.

Surgery undoubtedly owes an immense debt to Crile's researches. He has established for us the importance of the sphygomanometer in measuring shock, the value of cocaine blocking of nerve-trunks in preventing it, and the general principles of its avoidance and treatment. He has shown the futility of alcohol after ether or chloroform, and we now use strychnine much more cautiously since he has pointed out that its benefits are only transient, and that it may induce shock by exhausting the vasomotor centres if given in large doses. The pneumatic suit is too cumbrous to come into general use. Although saline transfusion into the vessels is a very ordinary mode of treatment of shock, it is doubtful whether the addition of adrenalin, which in the hands of Crile and Mummery gave such remarkable results, has become generally popular. As is well known, Crile has resuscitated by its means dogs apparently dead for fifteen minutes. Unfortunately it is necessary to give it continuously by the intravenous method in order to obtain prolonged benefit. The introduction into surgery of pituitary extract for the treatment of shock has diverted attention from adrenalin administration.

In spite of its fruitfulness in diagnosis and treatment, the Crile-Mummery theory is now undergoing a very powerful criticism. It is maintained by a number of competent observers, both clinical and experimental, (*a*) That the arteries are contracted, not dilated, during shock; and (*b*) That the vasomotor centre is not exhausted, even in extreme shock.

(*a*). The first thesis, that the arteries are contracted during shock, has been argued again and again by Malcolm. The pulse is small, the skin pale, bleeding is scanty, and warmth does the patient more good than cold. Even in the abdominal viscera the arteries are contracted and bleeding is less than usual, unless, of course, peritonitis is present. The renal vessels must be contracted, because there is anuria. There are no clinical phenomena, except the fall of blood-pressure, to indicate when the preliminary vasoconstriction gives way to the theoretical fatigue vasodilatation. Seelig and Lyon point out that the vessels of the retina are contracted even to a third their normal size, and indeed transient amaurosis has been recorded several times. It is only fair to Crile to add that he consistently describes the arteries as empty and the veins as full, both before and after death from shock.* It is difficult to understand how the arteries can be contracted if the vasomotor centre is paralyzed, since we know that it is continually sending out tonic impulses.

(*b*). That the vasomotor centre is not exhausted must be regarded as

---

* Crile, "Surgical Shock," p. 144.

proved by the following experiments of Seelig and Lyon, and of Porter and Quinby.

Seelig and Lyon measured the outflow of blood from the cut femoral vein of an animal in 5-second periods. The sciatic nerve was then cut, and the flow increased, the tonic vasoconstriction action being removed. They repeated the observation in extreme shock due to manipulation of the intestines. The outflow was of course less than normal. Then the sciatic nerve was cut; there was a prompt and very marked increase in the flow of blood. Therefore the vasomotor centre must still have been sending out tonic impulses.

Again, they found that in normal animals stimulation of the central end of the cut vagus, though painless, causes a rise of blood-pressure. This rise is just as high in proportion, if the stimulation is repeated on an animal in extreme shock. Therefore, again, the vasomotor centre is not exhausted. The possibility that the rise might be due to increased heart-action was eliminated by removing the sympathetic ganglia (stellate) on each side.

Porter and Quinby stimulated the central end of the sciatic nerve in cats for four hours. Though the experiment was repeated on many animals, they never obtained a fall of blood-pressure. It is only when there is a large wound or serous cavity exposed that a fall takes place. Again, Porter found that the fall of blood-pressure due to stimulating the depressor nerve is just as marked proportionally in extreme shock as in normal animals.

Tyrrell Gray and Parsons state that even when in an animal shocked from an operation on the lower limbs stimulation of the sciatic fails to cause any rise of blood-pressure, nevertheless stimulation of the brachial plexus will still do so. This they take to prove that the pain-impulses have exhausted the synapses (connections between the ascending sensory nerve-fibres and the cells in the cord) in the path from the legs to the centre, but that the vasomotor centre is not exhausted.

Again, as Crile himself showed, crushing the testes causes a fall of blood-pressure without any preliminary rise, presumably because there are only depressor and few or no pressor nerves passing from the testes to the centre. In this case, of course, the vasomotor centre cannot well be exhausted in the ordinary sense of the term.

The truth of the matter would appear to be that it is not the centre which is exhausted, but the pressor afferent nerves. Many sensory nerves contain both pressor and depressor fibres, stimulation of which leads to a reflex rise or fall of blood-pressure. The pressor reflexes are, in the limbs, most prominent at first; later they become fatigued and depressor reflexes appear.

Crile, and also Tyrrell Gray and Parsons, have worked out the reaction of all the principal organs to painful or destructive influences. The latter workers give a "shock-index" to the various parts of the body. They believe that "the shock value of a structure varies directly with the proportionate number of depressor nerves in its nerve-supply, and that the higher the shock value the greater the degree of resistance to infective lesions." That is to say, the more immune an organ is to bacterial invasion, the more dangerous will be mechanical injury to the same. (It is doubtful how far this can be maintained; the central nervous system is very vulnerable both to shock and to infection.)

Crile records a *rise* of blood-pressure following injuries of the skin, periosteum,

bladder, and uterus; a *fall* from injury to the testes, peritoneum and brain; and a rise followed by a fall from stimulation of nerve-trunks. Manipulations or other injuries of the connective-tissues, muscles, bone, eye, mouth, tongue, or kidney caused but little alteration. Gray and Parsons accord high shock values to bone, the great vessels, the central nervous system, and the kidney. The bladder and urethra have a low shock value, and injuries to the skin are only productive of marked shock when they cause pain, not when the patient is anæsthetized. Although trephining the mastoid does not induce shock, hammering does.

In the case of the abdominal cavity, two factors have to be considered, viz., the local vasomotor reflex and the general vasomotor reflex. Both Crile and the Arris and Gale lecturers lay stress on this. Alterations of the vascularity of the intestines will cause changes of the brachial or carotid blood-pressure quite apart from any impulses arising in the vasomotor centre in the medulla. Thus Crile shows that the usual fall of blood-pressure on manipulating the intestines is largely averted if the superior mesenteric artery is clamped. The shock value of the intestines cannot be estimated by means of a sphygmomanometer applied to the arm. It is unfortunately only too common for the blood-pressure to remain high while the surgeon is maintaining the vasoconstriction in the peritoneal cavity by the direct stimuli of his manipulations, but that afterwards, when these are removed, fatal collapse occurs. Thus the patient may be in shock with a high brachial blood-pressure.

According to Mummery and Symes, non-destructive lesions of the abdominal viscera cause more shock than gross injuries.

Before leaving this subject, it is interesting to note that Romberg and Pässler, in their classical research on toxæmia, arrived at a conclusion similar to that of Crile, namely, that the toxæmic shock which brings about the final fatality in most medical diseases is also due to exhaustion of the vasomotor centre. Like Crile, they base their theory largely on the fact that shortly before death occurs, stimulation of sensory nerves fails to induce a rise of blood-pressure by reflex arterial constriction.

2. **The Yandell Henderson Theory, that Shock is due to Acapnia.**—Although it is already five years since this theory was announced, and supported by a most laborious series of interesting experiments, yet it has failed to gain an adequate recognition in England. This is due to the fact that the publications have been made in an American journal of physiology. American surgeons are, however, now taking serious notice of it. The author is professor of physiology at Yale University. Very briefly, the theory is that shock is due to loss of carbon dioxide from the blood on account of the excessive breathing reflexly induced by painful stimuli.

Because carbon dioxide is exhaled from the body by the lungs, because, in conditions of asphyxia, the amount of the gas is greatly increased in the blood, it has perhaps been too readily assumed that it is nothing but a poison, and serves no useful purpose in the body and in the blood. Haldane and Priestley showed several years ago that the activity of the respiratory centre depends, in ordinary circumstances, entirely on the CO_2 content of the blood. When it rises above a certain figure, constant for the individual, respiration is stimulated.

It is not lack of oxygen, but excess of CO_2, that excites the centre. Lack of this gas, as after several deep respirations, causes a pause in the breathing called *apnœa*. Henderson's thesis is that not only does reduction of the CO_2 induce cessation of the activity of the respiratory centre, but it also reduces other important functions. This reduction of CO_2 is called *acapnia*, and it is suggested that acapnia is the prime cause of shock (*a* = lack of ; *capnos* = smoke).

According to Henderson, the deep and rapid breathing which is induced by pain, excitement, or exposure and handling of the intestines, reduces the CO_2 in the blood to a very low figure, whilst the oxygen, of course, is increased. This is undeniable, and his blood-gas analyses in animals bear it out. Therefore, when the stimulus ceases, breathing becomes very shallow and occasional, and at the same time the blood-pressure falls and the heart beats quickly. This condition may, and probably will, lead to death in animals. Henderson's theoretical conclusion is that the cause of death is due to lack of oxygen, the store becoming exhausted before the CO_2 rises high enough to stimulate the centre into activity again.

It is possible in animals, merely by excessive artificial respiration, to reduce the CO_2 so much that respiration is shallow, the heart becomes rapid, blood-pressure falls, and death ensues in about three hours. On the other hand, when pulmonary ventilation is reduced and the carbon dioxide in the blood is kept at or near its normal figure, very prolonged operations on dogs, extending over seven hours with the thorax opened, result in little or no shock. The rate of heart-beat and the blood-pressure can be varied exactly with the pulmonary ventilation. It is possible to make analyses of the blood gases from time to time with about 3 c.c. of blood by Barcroft's method. The means by which carbon dioxide can be restored, and shock prevented or removed, are : the infusion into a vein of saline saturated with CO_2, and the increase of the dead space of the respiratory apparatus by making the animal breathe through a long glass tube, so that there is a good deal of to-and-fro breathing of expired air.

How then are the fall of blood-pressure and the quickening of the heart to be explained ?

Crile and Henderson agree that there is no primary cardiac failure. After intravenous transfusion, for instance, the heart is perfectly capable of recovery. Henderson finds the primary cause of failure in the *venous pressure*. When there is a reduction of CO_2 in the blood, the walls of the veins and the tissues supporting them relax, the pressure in the veins falls, blood accumulates in them, and only a small amount is transmitted to the heart. For a time, by constricting the arteries, a fair blood-pressure can be maintained ; at last the supplies reaching the right auricle become so reduced that the arterial pressure falls, the heart-beat becomes quick, the output is small, and severe shock is now established. The quickened heart-rate may be due to some extent to escape from vagus control, the activity of the vagus centre suffering reduction, like that of the respiratory centre, on account of the low blood-content of carbon dioxide.

Some other factors of importance require mention. It is well known that operations involving exposure of the intestines, especially if they are handled and pulled about, are apt to induce shock. Henderson shows that when the abdominal viscera are exposed to a current of air, they rapidly exhale CO_2. The rate of loss is about forty times as great as that from the skin. Consequently there

is both a local and a general reduction of the carbon dioxide. The vessels of the peritoneum become dilated, peristalsis is reduced or inhibited altogether, and the systemic lack of CO_2 results in apnœa and, finally, the vascular phenomena of shock. It is well known that in partial asphyxia the intestinal movements are exaggerated. If the peritoneal cavity is filled with CO_2 gas, peristalsis is very active, like that seen with the *x*-rays in a normal animal, and quite unlike the quiescence which we are accustomed to observe under even slight anæsthesia. Saline fluid saturated with CO_2 also produces peristalsis, avoids the paralytic condition of the bowel which is a bugbear of abdominal surgery, and prevents the redness and congestion of the vessels induced by the wide acapnia. Whilst the handling and pulling are actually going on, the painful stimuli are sufficient to avert fatal respiratory failure. It is well known that any pain increases the rate and depth of breathing. If death from shock occurs at this stage, it will be by failure of the circulation. But as soon as the painful impulses cease, neither pain nor CO_2 is present to stir the respiratory centre into activity, and death by failure of breathing soon ensues. It is a commonplace that patients usually survive the operation itself, but may die of shock a few hours afterwards. Henderson found that even a few minutes' cessation of the stimuli would allow the animals to lapse into this fatal apnœa, while breathing could be restored on resuming the handling.

Deficiency of CO_2 in the blood has another remarkable effect. When the deviation from normal is considerable, there is a tendency for fluid to exude from plasma into the tissues with great rapidity. This was first demonstrated by Sherrington and Copeman. The plasma therefore becomes concentrated, and the total volume of the blood is diminished. This further reduces the output of the heart. When this outpouring has become established, transfusion ceases to be of more than temporary benefit. Early in the course of shock, the introduction of saline into a vein will cure ; later on it fails, because the fluid merely escapes into the tissues.

Shock, or a condition exactly analogous to shock, may be induced not only by injury or pain, but also by toxæmia. Whilst Crile was investigating the former condition, Romberg and Pässler were making observations on the latter. They found that toxæmic shock was identical in its main features with traumatic shock, and, like Crile, they considered that it was due, not to heart failure, but to exhaustion of the vasomotor centre after prolonged activity. According to Henderson, however, in both these conditions it is the venous pressure and the venous return to the heart which are subnormal in the first place, and the final fall in the arterial pressure is due, not to exhaustion of the vasomotor centre, but to the reduced output of the heart ; this reduced output, in its turn, being due, not to cardiac weakness, but to inadequate entry of blood along the venæ cavæ. Both Crile and the German observers laid great stress on the fact that stimulation of a sensory nerve fails to induce the usual rise of blood-pressure by reflex arterial constriction, when advanced shock is present, and they interpreted this as due to exhaustion of the vasomotor centre. According to Henderson, the truth is that the centre is already sending out its maximum of impulses, but that the pressure is low notwithstanding, because there is so little blood actually circulating. He remarks that if the arteries were paralyzed, an intravenous injection of saline would not raise, as it frequently does, the arterial

blood-pressure to normal, " because the blood would run out through the capillaries too easily for any pressure to be developed."

There is experimental evidence that the venous pressure is not regulated by the nervous system, but rises and falls with the amount of CO_2 in the blood. Adrenalin has no influence on it. The carbon dioxide acts partly by influencing the tone of the muscle in the vein wall and in the supporting external tissues, and partly by controlling the escape of fluid by osmosis.

The measures which Henderson used to *prevent* shock were to diminish the loss of carbon dioxide by keeping the artificial respiration very slow, and using a long tube attached to the trachea, so that a good deal of the expired air was in-breathed again. To *relieve* shock he adopted three measures, by :—

(*a*). Pouring warm saline saturated and bubbling with CO_2 into the abdomen, and closing the cavity.

(*b*). Transfusing warm saline saturated and bubbling with CO_2 into a vein.

(*c*). Allowing the animal to breathe in and out of a bag containing air or, better, oxygen.

The saline is saturated by shaking it in a flask through which carbon dioxide has been bubbled from a cylinder, or Kipp's apparatus ; it is then warmed. The delivery tube from the CO_2 cylinder may be introduced into the abdominal cavity, and the gas bubbled through the fluid.

Henderson sums up his theory of the causation of shock as a sequence following these lines : (*a*) Hyperpnœa ; (*b*) Acapnia ; (*c*) Failure of the venopressor mechanism (or sometimes sudden fatal apnœa) ; (*d*) Venous anoxæmia, tissue asphyxia, and acidosis ; (*e*) Acute oligæmia.

These researches are doubtless of great interest and full of suggestiveness. It may be taken as proved that animals under artificial respiration can be brought into a state of severe shock by excessive ventilation. If ever this mode of giving anæsthetics becomes popular in surgery this factor will have to be reckoned with ; probably much experimental work on shock has been vitiated in the past by unequal ventilation. Jerusalem and Starling have verified Henderson's observations on the effect of acapnia in the output of the heart, which is decidedly reduced when the CO_2 in the blood falls below normal.

It is very questionable, however, whether the condition of acapnia is responsible for the type of shock met with by the surgeon in ordinary cases. Henderson advances very little clinical evidence directly dealing with this important point.

The present writer offers the following objections to the acapnia theory :—

1. Henderson's suggestion that the patient dies from lack of oxygen is inconsistent with Haldane's observation that when the amount of oxygen breathed falls below 13 per cent of an atmosphere, the respiratory centre is governed by the quantity of oxygen in the blood, not by the CO_2, so that deficiency of oxygen would act as a stimulus to the centre (probably by producing acids in the tissues, these acids forming the actual stimuli).

2. Hyperpnœa due to painful stimuli does not appear to be a sufficient cause in surgical cases for the marked degree of acapnia necessary. The CO_2 often sank from 40 to 50 per cent down to 10 per cent in Henderson's animals in a state of shock. During an operation, fatal shock may come on in half an hour.

Again, shock would be impossible if Clover's inhaler were used throughout. Many anæsthetists believe that this inhaler does guard against shock, but it by no means abolishes it.

3. The writer has made direct observations on the carbon dioxide content of the blood in a number of clinical cases, and is unable to find any marked difference in the patients suffering from severe shock or allied conditions. In Henderson's cases the reduction of the CO_2 was extreme and could not be overlooked. Details of the writer's estimations are given at the end of this paper.

One would conclude, therefore, that surgical shock is not usually due to acapnia, though probably acapnia would produce a very similar condition. The most useful of Henderson's practical recommendations would seem to be that of using saline saturated with carbon dioxide in the peritoneal cavity to excite peristalsis after abdominal operations. Cotton has treated cases of surgical shock by making them rebreathe their carbon dioxide, but the results are not strikingly good.

3. **The Boise Theory, that Shock is due to Cardiac Spasm.**—Boise bases his theory principally on a critical examination of Crile's experimental work. He calls attention to the fact that crushing the testes causes a fall of blood-pressure from the first. This cannot, therefore, be due to exhaustion of the vasomotor centre, and must in Boise's opinion be due to cardiac failure. He points out, again, that Crile repeatedly found the heart and arteries in a state of spasmodic contraction after death.

To overcome the cardiac spasm, he suggests that veratrum viride should be used, as it increases diastole and lessens systole. Some experimental work is advanced in support of this conclusion, and it is argued that shock was averted. The details are meagre, and blood-pressures are not given ; in one or two cases the drug apparently caused death.

The fallacy underlying Bose's contention is that he omits to take account of depressor nerve fibres. The blood-pressure falls when the testes are crushed, not necessarily because of cardiac failure—and indeed it may occur when the vagi are cut,—but because of depressor stimuli to the vasomotor centre. One would hesitate to use a powerful cardiac depressant like veratrum when the patient's vital powers are already at a low ebb.

Crile, Mummery, and Yandell Henderson agree that there is good evidence that the heart has not seriously failed in shock. When saline is injected into the circulation it responds well and beats strongly. The output of the ventricles is of course very small in shock, but this is due to deficient filling from the great veins, not to impaired contractile power. Crile remarks on the fact that the mammalian heart, if its vessels are perfused, is so little liable to run down that it will actually beat for hours after removal from the body.

4. **The Meltzer Theory, that Shock is due to Inhibition of the Functions of all the Organs, beginning with the less vital and spreading to the more vital.**—Meltzer's principal experimental work relates to the inhibition of the peristaltic movements of the intestines when the abdomen is opened, or even when an extensive skin dissection is undertaken. A more severe

injury, according to the theory, would inhibit the functions of the spinal cord, and finally, of the great centres in the medulla.

This conception of the pathology of shock appears to be an abandonment of the problem. We are left in the dark as to how the inhibition is brought about, or as to which are the most significant stages in the process of failure. The experimental research on the movements of the intestines is not very satisfactory. It is not clear how far their quiescience was due to the anæsthetic, or to exhalation of carbon dioxide from exposure.

Some Further Considerations.—There are some phenomena of shock which do not form an integral part of any of the theories we have discussed, but which are probably of great significance.

Oligæmia.—Roy and Cobbett, and also Sherrington and Copeman, have demonstrated that, in conditions of shock, fluid transudes out of the blood into the tissues, either locally at the site of trauma, or generally all over the body. This has been accepted by Mummery, Malcolm, and Henderson, different as their views are in other respects. This reduction in the total quantity of the blood is proved by the rise in the specific gravity.

The very serious consequence is that the heart fails to obtain a proper influx of blood from the veins, and hence the output is reduced. This by itself would be sufficient to account for the low blood-pressure and the contracted state of the arteries.

The rise of specific gravity may be as much as from 1·054 to 1·062 in fifteen minutes during an intestinal anastomosis. Peritoneal operations and burns are the causes of the greatest rise. Probably the thirst of shock is due to this phenomenon. Perhaps also it accounts for the fact to which Mummery and Symes call attention, that hypodermic injections are very badly absorbed during shock.

Changes in the Nerve-cells.—Dolley and Crile find remarkable changes in the nerve-cells of the central nervous system, and especially in the Purkinje cells of the cerebellum, during shock. The animals used were dogs, whose intestines were pulled about. The brain cells increased in size, burst their limiting membrane, and suffered dissipation of their Nissl bodies. The cells of the spinal cord were not changed. Ether allowed of more damage than nitrous oxide. In frightened rabbits, the changes were similar but slighter.

Tyrrell Gray and Parsons appear to have found the changes much less marked. They were best shown in the cuneate and gracile nuclei of the medulla. The cells of the vasomotor centre were not altered.

Changes in the Suprarenals.—At two autopsies on patients who died in shock, Bainbridge and Parkinson failed to find any chromaffine substance in the medulla of the suprarenals. Priestley (quoted by Tyrrell Gray and Parsons) found that it was absent in 84 per cent of cases of low blood-pressure. The significance of these observations is, of course, that the suprarenals are continually furnishing adrenalin to the circulation, the adrenalin forming a chemical link between the vasoconstrictor nerve-fibres and the muscle of the arteries without which vasoconstrictor impulses have no effect. If it were established that absence of the chromaffine substance indicates deficiency of adrenalin, and that these changes are constant in shock, we should have to conclude either that the

suprarenal failure is the prime cause of shock, or more probably, that prolonged powerful vasoconstriction has used up all the available adrenalin and exhausted the further supply.

GENERAL CONCLUSIONS.

It will be gathered from the foregoing that none of the theories at present before us are altogether satisfactory. The Crile-Mummery hypothesis of exhaustion of the vasomotor centre is discounted by the evidence that the arteries in shock are constricted, and by the experiments of Seelig and Lyon, and of Porter and Quinby. Tyrrell Gray and Parsons appear to demonstrate that the exhaustion is in the afferent paths, not in the centre. It is possible that much of the experimental work of all these observers who have employed artificial respiration has been vitiated by acapnia " shock," in the absence of details as to the regularity of the ventilation. This may account for discrepancies in the results.

The carbon dioxide estimations set forth in our concluding section seem to show that Yandell Henderson's acapnia theory will only account for a few, if any, types of clinical shock. Boise's explanation, that heart spasm is the cause, is rendered improbable by the excellent recovery the heart makes after transfusion. Meltzer's theory seems to abandon the problem.

It would appear to the present writer that insufficient stress has been laid on the oligæmia or concentration of the blood by loss of fluid to the tissues and also to the injured area. The fact of its occurrence has been proved by Sherrington and Copeman, and by Roy and Cobbett. It is acknowledged by Mummery, by Malcolm, and by Yandell Henderson. We know how in cholera, in infantile diarrhœa, or after hæmorrhage, acute loss of fluid rapidly induces shock. Even those who, like Mummery, believe that there is an essential difference between shock and collapse (due to loss of fluid) agree that there is an identical clinical picture, except that the rate of onset may differ.

In this diminution of the volume of the blood we may find the explanation of most of the acknowledged facts. It solves the crucial problem of a low blood-pressure with constricted arteries, vigorous heart muscle, and an active vasomotor centre. The changes in nerve-cells are due to failure of their proper blood-supply, and the mental apathy is the natural result of the same. The small pulse, pale skin, and anuria are just what we should expect in such a condition. The undoubted value of saline infusion into a vein, or injection into the rectum, also receives explanation.

No doubt there comes a time, in the progress of shock, when the *vis a tergo* from the heart acting on the small volume of blood in the rigidly contracted arteries, fails to exert any effective pressure on the blood in the veins, and as the enfeebled respiratory movements cannot supply a sufficient suction or *vis a fronte*, the output of the heart is reduced more and more in consequence of the alarmingly small quantities that enter the right auricle. Thus the splanchnic veins may be over-filled.

Before we can accept oligæmia as the main factor in the pathology of shock, we must explain how it is produced, and how it accords with the experimental facts described by Crile, Mummery, and others. We must also explain why saline transfusion is only a partial success in many cases, whereas one might expect that it would be an infallible cure.

The exudation of plasma from the capillaries is not a process of mechanical filtration, but is governed by those obscure activities of the endothelial cells which we call vital. In ordinary, any cause which raises the pressure within the capillaries will lead to increased lymph flow, and a fall stops the flow. Thus, after ligature of the inferior vena cava above the diaphragm, the flow from the liver is greatly increased and that from the rest of the body is abolished, owing to the small output of blood from the heart (Heidenhain, Starling). Atropine, however, whilst increasing the vascularity of the part, stops the production of lymph. Lymph-formation goes on after death so long as the endothelial cells of the capillaries survive. The increased output of plasma from the blood in shock is partly due to the generalized rise of pressure in the capillaries from reflex vasoconstriction, and partly to the outpouring of plasma into the damaged area that originates the shock. Porter explains the difference between his experiments, in which stimulation of the sciatic never caused a fall of blood-pressure, and Crile's, in which extensive injuries to the limbs or abdomen did cause such a fall, by the much larger area in which exudation of lymph can take place in the latter case.* The peritoneum, for instance, would take a considerable quantity of fluid from the blood. Sherrington found that there was a rise in the specific gravity from 1·054 to 1·062 in a quarter of an hour when the intestines were sutured end to end. If even this by no means severe surgical procedure produced the same change in the specific gravity of the blood in man, it would correspond to a loss of about 25 oz. of fluid from the circulation. Now it is true that a hæmorrhage of 25 oz. may not be serious, because the loss of fluid is rapidly made good by the influx of water to the blood from the tissues, but in shock this compensatory dilution will not occur, and therefore symptoms would probably appear in consequence of the oligæmia. Longer and more severe operative procedures would produce a greater rise in the specific gravity than this.

One seldom sees many ounces of serum poured out into an injured area, if the peritoneum be excepted; therefore we must conclude that the principal loss is into the tissues all over the body, the fluid being squeezed out, at first, by the generalized vasoconstriction. Later, as we shall see, the excretion is continued by the vital activity of the endothelial cells lining the capillaries. It is interesting to note that Mummery and Symes found that when the arteries are dilated after excision of the spinal cord, the specific gravity of the blood falls, fluid being taken in from the tissues to fill the relaxed vessels.

It is not denied for a moment that fall of blood-pressure in shock, and especially at the beginning, may be due to vasomotor reflexes by the stimulation of depressor nerves. This is no doubt the explanation of the immediate drop which follows crushing the testes. But is this really the same thing as the shock of a prolonged surgical operation such as amputation at the hip joint or removal of a large cancerous tumour from the bowel? We venture to doubt it. Sudden stimuli may cause an immediate reflex fall of blood-pressure by impulses passing

---

* There is another explanation of the facts. Electrical stimulation of a nerve, with such a current as Porter used, only excites those nerve-fibres which lie nearest to the electrodes, not the whole bundle. A large wound, therefore, provides effective stimulation of many more nerve-fibres.

up the depressor afferents after the pressor afferents have been fatigued, and of course a sudden vasodilatation in a patient who is already suffering from a severe reduction in the quantity of the blood may lead to fatal collapse or other alarming symptoms. Perhaps in some cases, what is described as sudden fatal shock is really reflex vagus inhibition of the heart, such as takes place in patients half under chloroform. The classical experiment of Goltz, who stopped the heart by tapping a frog's intestines, must be borne in mind. Vagus inhibition is quite a different thing from the primary cardiac spasm of the Boise theory.

Strychnine induces shock, according to Crile, by exhaustion of the vasomotor centre after prolonged excitation, but the preliminary contraction of the blood-vessels and activity of the muscles might quite well cause oligæmia by the outpouring of lymph.

Nerve-blocking by cocaine derivatives is a valuable preventive of shock, because it prevents the reflex vasoconstriction and the generalized outflow of plasma all over the body. It also limits the local outflow in the injured area by abolishing reflex vasodilatation in that region.

Adrenalin transfusion will temporarily revive an animal apparently shocked to death, by constricting down the arteries yet further on what little blood remains in them, reinforced as it is by the saline, and so a better blood-pressure and more *vis a tergo* to drive the blood on through the veins into the heart is obtained. It is doubtful, however, if it will not lead again to a squeezing out of the plasma through the capillary walls. The same is true of pituitary extract and strychnine.

Why does not saline transfusion save the patient by restoring the lost fluid? It is not exactly an explanation, but we do know as an established fact, when the capillary endothelium begins to secrete fluid through into the tissues, and keeps up the action for some time, that it becomes difficult to check it. Lazarus Barlow demonstrated this very clearly in his well-known experiments. When saline fluid is injected into an animal in a state of collapse, the specific gravity falls at once (e.g., from 1·064 to 1·054), but immediately begins to rise again *and overshoots the mark* (reaching 1·067). This does not occur, however, after three or four repeated transfusions. Of course, if transfusion is delayed until the brain cells are dying of anæmia, it will be useless.

A very few words must suffice with regard to treatment. Although adrenalin, pituitary, and strychnine may temporarily raise the blood-pressure, it is not conclusively proved that they are of permanent value in shock, though they may tide the patient over an emergency. Saline transfusion is the main hope, and it ought to be repeated. The value of nerve-blocking in averting shock is undeniable, and Tyrrell Gray and Parsons make out a good case for the preventive influence of intraspinal anæsthesia.

SUMMARY.

1. Four theories of shock are before us: (*a*) The Crile-Mummery theory, that the vasomotor centre is exhausted; (*b*) The Yandell Henderson theory, that shock is due to acapnia (deficiency of CO_2); (*c*) The Boise theory, of primary cardiac spasm; (*d*) The Meltzer theory, that in shock all the functions of the organs are inhibited, from the less vital on to the more vital.

2. It is objected to (*a*) That the arteries are contracted and that the vasomotor centre is not exhausted; to (*b*) That acapnia is not present in surgical shock; to (*c*) That the heart muscle still responds excellently after saline transfusion; to (*d*) That it is an abandonment of the problem.

3. Three further phenomena remain to be accounted for: the oligæmia (= diminution in volume of the blood), the degenerative changes in the nerve-cells, and the loss of chromaffine substance in the suprarenals.

4. The most probable cause of shock, in the writer's opinion, is oligæmia, induced by loss of fluid partly into the injured area, and partly through the capillaries all over the body in consequence of reflex vasoconstriction due to stimulation of the pressor afferent nerves. Sudden collapse may then be precipitated by stimulation of the depressor afferents.

PROTOCOL OF EXPERIMENTS ON THE CO_2 CONTENT OF THE BLOOD IN SURGICAL SHOCK.

Method.—About 1 c.c. of blood was withdrawn from the superficial veins of the arm, with aseptic precautions, into a close-fitting hypodermic syringe containing 2 min. of oxalate solution. The blood was expelled immediately beneath the surface of 0·5 per cent of ammonia, and the CO_2 liberated by tartaric acid and estimated by Barcroft's apparatus in a water-bath to maintain a constant temperature.

Normal Cases:—

1. A. R. S., healthy male adult, not under anæsthetic. $CO_2 = 45·8$ per cent.
2. C. W. J. B., healthy male adult, not under anæsthetic. $CO_2 = 41·1$ per cent.
3. Male, aged 25. Wiring fractured tibia. No shock. Taken at beginning. Anæsthetic, ethyl-chloride-ether, by Clover's apparatus. Not cyanosed. $CO_2 = 39·7$ per cent.*
4. Male, aged 50. Healthy. Double castration. No shock. Anæsthetic, open ether. At beginning, pulse 84, $CO_2 = 46$ per cent. At end (three-quarters of an hour later), pulse 96, $CO_2 = 51·5$ per cent.
5. Male, aged 14. Hernia. No shock. Open ether and chloroform. Taken at end. $CO_2 = 54·4$ per cent.

Cases with Shock:—

6. Male, aged 14. Perforated wound of the urethra and intestine (four holes), by perineal wound fourteen hours before. Early peritonitis present. Looked bad; pulse 120, blood-pressure 105. Died a week later of empyema. Blood taken near end of operation. Chloroform—open ether. $CO_2 = 52·1$ per cent.
7. Female, aged 50. String cancer of colon causing chronic obstruction, removed. Pale, pulse 75, but shock only slight. Taken at end. Open ether. $CO_2 = 48·9$ per cent.
8. Male, aged 27. Perforated gastric ulcer. Pulse 100 to 120, blood-pressure 104. Sample taken during pulling on viscera. Open ether. Died eighteen hours after. $CO_2 = 42·5$ per cent.
9. Female, aged 64. Vomiting five days, now fæcal. Loop of gangrenous gut resected, ileostomy. Seven days later second operation for lateral anastomosis, lasting seventy minutes. Sample taken at the end; pulse 120, blood-pressure could not be obtained because of feeble pulse. Chloroform—open ether. Died fourteen hours later. $CO_2 = 44·2$ per cent.
10. Male, aged 40. Cancer of colon; acute intestinal obstruction twelve hours, incessant vomiting. Chronic obstruction preceding. Very bad. Pulse 140. Sample taken during manipulation of bowels. $CO_2 = 46·8$ per cent.

---

* This figure, an early experiment, is probably too low.

Cases with Cyanosis :—

In two cases the anæsthetist called my attention to the fact that the patient showed decided cyanosis.

11. Man, aged 30. Hernia. No shock; blood-pressure 140. Ethyl-chloride—ether, in Clover. $CO_2 = 74{\cdot}2$ per cent.

12. Man, aged 22. Hernia. No shock. Ethyl-chloride—ether, in Clover. $CO_2 = 59{\cdot}5$ per cent.

These cases bring out the facts that cyanosis very decidedly raises the CO_2 content of the blood, but that shock does not lower it. Henderson claims that acapnia is the cause both of traumatic and toxæmic shock. In five normal cases CO_2 was 46·4 per cent, in five shock cases 46·9 per cent.

REFERENCES.

A. Papers of main importance :—

CRILE, *Surgical Shock*, New York, 1897.
CRILE, *Blood-pressure in Surgery.*
CRILE, *Trans. Amer. Surg. Assoc.*, 1910, xxviii, 553.
CRILE AND DOLLEY, *Jour. Med. Research*, Boston, 1909, xx, 275.
YANDELL HENDERSON, *Shock, Intern. Med. Monographs*, 1913.
YANDELL HENDERSON, *Amer. Jour. of Physiol.*, 1908, xxi, 126; 1909, xxiii, 345 xxiv, 66; 1910, xxv, 385; xxvi, 260; xxvii, 152; 1911, xxviii, 275.
MUMMERY, *Lancet*, 1905, i, 696, 776, 846.
BOISE, *Amer. Jour. of Obst.*, 1907, lv, 1, 95.
BAINBRIDGE AND PARKINSON, *Lancet*, 1907, i, 1296.
SHERRINGTON AND COPEMAN, *Jour. of Physiol.*, 1893, xiv, 52.
SHERRINGTON, *Proc. Roy. Soc.*, 1894, lv, 161.
MALCOLM, *Lancet*, 1905, ii, 573.
MALCOLM, *Med.-Chir. Trans.*, 1907, xc, 563.
MALCOLM, *Clin. Jour.*, 1909, xxxiv, 328.
SEELIG AND LYON, *Jour. Amer. Med. Assoc.*, 1909, lii, 45.
SEELIG AND LYON, *Surg. Gyn. and Obst.*, 1910, xi, 146.
PORTER AND QUINBY, *Amer. Jour. of Physiol.*, 1907, xx, 444, 500.
ROMBERG AND PÄSSLER, *Deut. Archiv. f. klin. Med.*, 1899, lxiv, 652.
MELTZER, *Archiv. Intern. Med.*, 1908, i, 571.
TYRRELL GRAY AND L. PARSONS, *Brit. Med. Jour.*, 1912, ii, 938, 1004, 1065, 1120.

B. Reviews and less important references :—

MANSELL MOULLIN, *Intern. Encyclop. Surg.*, 1882. } These sum up the literature to
GROENINGEN, *Ueber den Shock*, Wiesbaden, 1885. } that date.
MUMMERY AND SYMES, *Brit. Med. Jour.*, 1908, ii, 786.
MUMMERY AND SYMES, *Jour. of Physiol.*, 1907, xxxvi, 15.
ALLPORT, *Surg. Gyn. and Obst.*, 1909, viii, 388.
JOHNSON, *Archiv. Middlesex Hosp.*, 1909, xvii, 41.
FALCONER, *Montreal Med. Jour.*, 1910, xxxix, 678.
POWELL AND OTHERS, *Brit. Med. Jour.*, 1910, ii, 757.
JERUSALEM AND STARLING, *Jour. of Physiol.*, 1910, xl, 279.
COTTON, *Boston Med. and Surg. Jour.*, 1912, clxvii, 432.
LAZARUS BARLOW, *General Pathology.*

VISITS TO SURGICAL CLINICS AT HOME AND ABROAD.

PROFESSOR SIR WILLIAM MACEWEN AT THE UNIVERSITY CLINIC, GLASGOW.

It is very difficult within the compass of a short article to speak of the operative technique of Macewen, without being tempted to wander from a consideration of the work to a description of the worker. His personality is so dominating, and the work he has done so immense, that it seems almost petty to be content with merely describing the trivial incidents of a single day.

Yet these incidents are each of them the outcome of keen scientific research and the tested experience of forty years of surgical work, lived during that very crisis of surgery out of which our modern art has been evolved.

Sir William Macewen has held the Regius Professorship of Surgery in the Glasgow University since 1892, and before that he held various appointments which enabled him to take an independent stand as a student and teacher of surgery, without allowing himself to be enslaved by the exigencies of private practice.

In his present position he has fifty beds under his direct care. The University Clinic is held at the Western Infirmary, and in the University he delivers lectures on systematic surgery and has extensive laboratories devoted to scientific research.

His wards are three in number, and with the operating theatre and lecture room, constitute a compact hospital unit.

Pathology is carried out by his own assistants under his immediate supervision, and both this and clinical photography are done by the staff, without the intervention of a specialist, except in rare cases.

The operating theatre is large, lofty, and very brightly lighted by windows in the roof and on three sides. Ample accommodation for students is afforded by raised seats, the entrance to which is apart from the body of the theatre. The floor space is very fully occupied by a number of stands and tables for instruments and dressings, besides the operating table, a wood and canvas screen, a full-sized photographic camera, and other accessories.

There is an excellent system of heating by steam. Ventilation is by an extracting electric fan, and the whole theatre can be washed out by steam. The main stock of instruments is kept in an adjoining room, but those required for each operation are sterilized by boiling in the theatre itself. This and the sterilization of water, is by superheated steam, so that there are no gas flames in the theatre.

The operators' hands are prepared by scrubbing with a sterilized nail brush and washing under running water with soft soap. The latter is stored in muslin

bags of about one cubic inch capacity after it has been sterilized. Such a mass of soap is scrubbed into the hands and forearms until nothing but the muslin covering is left, and a blunt instrument is freely used under all the finger-nails. The soap is rinsed off and a culture taken from under the finger-nails and from any other part of the hand, and the hands put to soak for two minutes in 1–20 carbolic acid solution: this time is measured by a time-piece attached to each wash-basin. This seems somewhat astonishing, and calculated to make the skin rough and sore, but it has been found that it is only at first, or after a holiday, that the skin shows any resentment, and during the ordinary course of work,

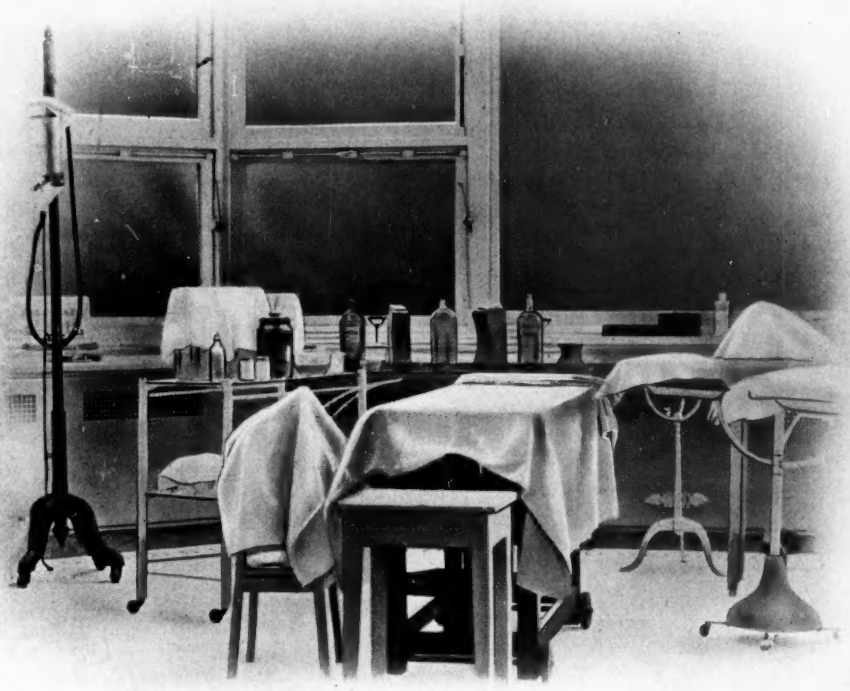


FIG. 59.

when it is repeated many times a day, no discomfort follows. After the carbolic has been washed off in sterile water, another culture is taken from under the nails and a final rinse given in spirit. The patient's skin is prepared in a somewhat similar manner over a longer period, the spirit stage being the only part of the preparation used on the table. A sterilized gown is worn which comes down to the elbows only. The head is enveloped in a gauze bandage which covers all but the eyes; sterilized spectacles are put on as the last act of preparation. In the majority of cases the cultures taken from the hands after soap and water only, show no growth, whilst after the carbolic they are invariably sterile.

The table used is a massive and antique wooden structure, and attracted attention by reason of its contrast to the product of the modern instrument-maker's art. Sir William, noting this, said he retained it in order that students might be impressed by the fact that modern surgery could be done quite well on a simple wooden table.

During major operations there are usually three assistant surgeons besides the house surgeon, the sister and several nurses. The sister has sole charge of the instruments and ligatures. One nurse is detailed for the sterilization of the gauze and other fabric used in the theatre and during operations, and she also hands the material, such as dry gauze for cleansing the wound, direct to the operator. Gloves are not worn by Macewen, unless he is dealing with a septic case. The assistants wear gloves. Catgut is the routine material used for ligatures and sutures. Silk is employed for intestinal work, wire and catgut are employed for bone.

The catgut for surgical purposes is prepared in the Clinic, none being used as received from the shops. The catgut is prepared by a special method which aims at two things: first, rendering it sterile; and second, making it answer to a physiological test—the absorption of the strands in the living tissue taking place within definite periods.

The basis of the preparation is steeping the gut in a solution of chromic acid in glycerin, and, after it has been prepared, keeping it in a 1–20 solution of carbolic acid in glycerin. When the catgut is about to be handed to the operator, it is rinsed in absolute alcohol.

In suturing, the catgut thread is usually knotted once in the eye of the needle to prevent the thread from being drawn out. The same store of ligatures is used for case after case, care being taken that no contamination takes place, and all the material not actually used being retained in the 1–20 carbolic and glycerin.

A basin of 1–40 carbolic acid solution stands on each side of the table, and into these, each of the participants in the operation constantly dip their hands.

The anæsthetic is administered by one of the house surgeons or by the students who have already passed an examination on anæsthesia and anæsthetics, under supervision. Chloroform on the open mask is the routine method, and Macewen states that if the administrator is properly competent, this is the best and safest anæsthetic.

It so happened that on the occasion of our visit there were only simple cases for operation, but each of these afforded some points of interest.

The first case was one of scirrhus mammæ. Macewen stood on the opposite side to the breast which had to be removed. After the skin incision, the skin edges were excluded by layers of white gauze, clipped to them by catch artery forceps. The greater part of the axillary dissection was carried out before the division of the great pectoral muscle or the removal of the breast. Every bleeding point was caught up and ligatured with the minutest care, and the operation was conducted with the neatness and precision of an anatomical dissection. Much more importance is attached to careful accuracy than to speed, but nevertheless there is no time lost either by the operator or by those who assist him. The cutaneous incision resembled the Greek letter ∂ in outline. It commenced at the apex of the axilla, the skin being reflected posteriorly to

the latissimus dorsi. The whole of the axillary cellular tissue was then dissected up from under the border of the latissimus dorsi and rolled forward to under the pectoral muscles. The axillary artery and vein were carefully cleared, the latter being exposed for about three inches in length—three tributary veins and one small artery being ligatured close to the main axillary vessels. The finger then further explored the sub-clavicular space. After this, the pectoralis major was exposed to the clavicle and was then detached from its sternal origin and reflected along with the mamma and its axillary fat, lymphatic vessels and glands, all in one piece.

After all bleeding vessels had been secured, the skin edges were brought together by clip artery forceps placed about one inch apart, except at one point, where the end of a long piece of gauze which had been packed into the axilla, was left projecting. The wound was very accurately sutured by a continuous blanket suture of fine catgut held in a curved needle and wielded by an instrument which combined the function of a scissors and a needle-holder. The gauze was removed before the last stitches were inserted. The wound was washed with spirit and covered by a single strip of gauze painted on by an ether solution of celloidin. A large covering of wood wool wrapped in gauze was bandaged over the whole. No drainage of any kind was used, and we understood that his is the case in all aseptic cases, even in excisions of joints or goitres.

Such clean cases require no change of dressings. At the end of ten days to a fortnight the celloidin gauze peels off, taking with it the superficial parts of the catgut stitch, the deep parts having been absorbed in the wound.

The other cases seen were: varicose veins, treated by the "garter" operation (an incision half-way round the upper and inner part of the calf down to the deep fascia, both ends of all divided veins being ligatured): the injection of iodoform emulsion into the abscesses round a tuberculous sacro-iliac synchondrosis; the removal of diseased parts of a tuberculous astragalus by means of a burr and hand brace; and a fractured patella. In the latter, the bone had been broken by direct violence, and the upper fragment was rather comminuted. A longitudinal incision was made over the bone and into the joint, and all blood-clot removed. Blood-clot, according to Macewen, is never a means of repair, but only a dead product which must be absorbed before repair can take place. The aponeurosis was removed from between the fragments. Each fragment was drilled by a rotatory drill, and a single longitudinal silver wire suture placed and twisted. The aponeurosis was sewn by transverse catgut stitches across the bony gap. The skin wound was treated, as in the breast case, without drainage. The limb was put up in plaster, which was to be left on for rather over a week.

It is impossible to close this brief note without referring to the teaching which forms so large and remarkable a part of Macewen's work. The first point to be observed is that the teacher himself is by far the keenest student in his class, ever alert to question and challenge the truth of text-book statements. We heard him remark: "Text-books are generally written in drawing rooms, and not by the side of the patient."

Clinical surgery is taught in the most practical and systematic manner by Macewen with the aid of three University assistants, of whom Dr. John Macewen is the chief. The teaching aims at making the students observe and think.

They are taught to apply their anatomical, physiological and general biological knowledge to the living pathological conditions with which they are confronted in the wards.

The students are taught to make their own observations and deductions from the cases submitted to them Cases are grouped so as to illustrate common diseases, and with those are shown other cases likely to be confused with them.

Having had clinical demonstrations on a given disease, illustrated by many examples, the class is taken over the subject in every possible phase, as shown by casts, specimens, and photographs, of which an enormous collection exists, resulting from a long life spent in daily observation.

A man must be dull indeed if he does not get from such teaching, not only a knowledge of facts and a capacity for observation, but something of that enthusiasm in the quest of truth and light, and keenness for applying the principles of treatment, which have made their teacher one of the greatest of living exponents of the art of surgery.

It is a pleasant duty to express our warm thanks to Sir William Macewen for his great kindness in affording every facility for writing this article, and allowing us to see many of the original specimens, upon which his iconoclastic work on the growth of bone has been founded.

In fact, only one of many requests was met by a refusal, and that was when permission was sought to take a photograph of the surgeon in his theatre. Readers must therefore be content with a picture taken by Dr. John Macewen, showing the theatre just before an operation was begun.

PROFESSOR TUFFIER AT THE HOSPITAL BEAUJON, PARIS.

In visiting the Hospital Beaujon and watching the work of Tuffier, one is struck by the remarkable contrast between the obsolete character of the building and the fresh vigour of the man.

One of the twenty or more hospitals under the control of the public service of Paris, the Beaujon dates back to 1750, being one of the oldest in the city. It has 400 beds, of which eighty are in the service of Professor Tuffier. He attends every week-day morning at 9.30, operating and doing a clinical round on alternate days.

Fig. 60.

It was our good fortune to be present on several occasions when there were operations and cases of considerable interest, and we will endeavour to select those points which most arrested attention.

As regards general operative technique, the dry aseptic system is followed. Practically all the operator's clothes are removed and replaced by light vest and trousers. A long gown, separate tight-fitting woven sleeves, cap with mask attached, and thin gloves, complete the outfit. A noticeable point was, that the gloves were put on as the last act of preparation before beginning the operation, the arrangement and fixation of towels and the handling of instruments by the surgeon and his assistant being done with the bare hand. The hand sterilization is by alcohol (1 min.), after soap and water (10 min.). In the ordinary course of operations, the gown and sleeves are not changed between one operation and the next, unless some septic complication is encountered. The preparation of the patient's skin is in two stages, by soap and water (shaving if necessary) and alcohol and a dry dressing as a first stage in the wards, and by a 10 per cent solution of iodine in alcohol painted on by the operator at the last moment.

The anæsthetic is given by a third-year student, who has a course of a few practical lessons before he or she is entrusted with this duty. Closed ether is the routine general anæsthetic, and it is given in Ombredanne's apparatus, which closely resembles Clover's inhaler, except that the bag is only of small capacity and is made of skin.

The instruments necessary for each case are sterilized in a separate round, flat metal box, by dry heat at 120° C., the accuracy of attainment of this temperature being attested by the colouring of a powder with this melting-point

contained in a small tube, mixed with some powdered aniline dye. On removing the lid of this metal case, the under portion of the same serves as the tray for the instruments throughout the operation.

A similar case of instruments is provided for the assistant, containing chiefly pressure forceps, towel clips, clamps, etc.

Enough routine instruments are kept in stock for four or five ordinary major operations, without using the same again.

The only ligatures used are catgut, sterilized by heat only and stored in alcohol. That most commonly employed is very thick (No. 2), and the tendency

FIG. 61.

is to pick up and encircle comparatively large masses of tissues rather than to ligature individual vessels. The actual tying of ligatures is done by the assistant.

Suturing is done by large transfixing needles on handles, the eye at the point, threaded after insertion, the suture being placed by withdrawal of the needle. The great majority of the sutures are interrupted, but for the rarely used continuous suture, separately threaded sewing needles with fine thread are provided, each in its own glass tube. Even in sewing the stomach or intestine and fixing them to the parietes, the interrupted stitch placed by withdrawing a big handled needle was the rule.

The swabs are folded layers of plain gauze about 5 in. square. They are

used in great numbers and are not counted; but when left in the wound each is usually attached to a pressure forceps.

Only one large slit towel covers the wound area; but many sheets of gauze, 18 in. by 12 in., are provided, and these are not only clipped to the edges of the wound, but are laid on over the area round the operation at frequent intervals with lavish profusion.

The sister in charge, both of the female wards and of the operating theatre, has one female and two male nurses available in the latter department, and she achieves a wonderful organization of all the preparatory technique. At a word or gesture from the operator or his assistant, anything required is at hand.

There are two operating rooms—one is reserved for specially septic cases, and the other is used for the ordinary routine of work—opening from each side of a middle anæsthetic room. As there are always several students available for anæsthesia, the latter is administered to the second patient almost before the operation on the first is completed. This, together with the system of separate canisters of instruments and dressings ready prepared beforehand, and the perfect co-operation of the sister and her subordinates, makes it possible to conduct the maximum of operative work in the minimum of time.

In the short interval between operations, Professor Tuffier explains all the principal points of interest in the case which he has just completed, with the aid of chalks (sterilized) and a blackboard which is let into one wall of the theatre.

The first operation the Professor performed was for a fracture of the patella. A simple transverse incision was made, and great care taken in turning up all the torn fragments of the aponeurosis from the front surface of the bone. A single strand of No. 2 catgut surrounded the bone in a horizontal plane, and by several further sutures the aponeurosis was sewn in front of the patella. This case, three days afterwards, was seen, together with a skiagram. The fragments were in good position, but were separated by an interval of nearly $\frac{1}{4}$ in. Tuffier makes a great point of leaving no unabsorbable foreign body in the tissues.

The next case was that of a tuberculous elbow in a young woman. The condition was one of very early disease. A typical excision was performed through a median posterior incision, the ends of all three bones being freely removed. Then, in order to prevent ankylosis, the ends of the radius and ulna were covered in a sheet of tissue derived from the patient's fascia lata, together with the overlying fat.

Prof. Tuffier employs this transplantation of the fascia lata very frequently, and has never yet had to remove the grafted tissue on account of necrosis. He showed me in this connection a most interesting case of traumatic ankylosis of the elbow which he had treated by the transplantation of the lower end of the tibia removed from an amputated limb and kept in cold storage for some days. The skiagrams showed very clearly the stages in the course of union of the graft to the shaft of the humerus.

The third case was one of double suppurative salpingitis, or pyosalpynx. The tubes were both removed with the body of the uterus, and drainage was provided by freely splitting the cervix and putting a large rubber tube into the vagina. The peritoneum was brought together by a few stitches across the stump of the cervix, but the tube projected above this peritoneal union. This drain is taken away within twenty-four or forty-eight hours.

The last case was a gastrostomy for an old man in a very exhausted condition with cancer of the œsophagus. Only local anæsthesia was administered. This was rapidly effected by means of an apparatus consisting of a small bottle containing about 4 oz. of a 1 per cent solution of stovaine, connected with two tubes, one joined to a hand pump and the other to a hollow needle. By working the hand pump a continuous stream of the anæsthetic solution is forced into the tissues in various directions with a single puncture of the needle. The incision was median. No attempt was made to form a valve of any kind. A part of the stomach wall at the front of the lesser curve was sewn to the parietes by interrupted thread sutures which only took up the serous layer. A small stab incision was made into the cavity of the viscus, and into this a catheter was fixed by a suture to the abdominal wall.

Prof. Tuffier finds this method the most effective in preventing gastric regurgitation. It is based on two principles. The first is that an aperture in the upper part of the stomach has little or no tendency to act as an exit for the gastric contents: the second depends on the fact that the muscle is not caught up in the suture, and therefore, when the stomach contracts, the muscle closes the artificial stoma. In this patient, when seen a week later, there was no evidence of leaking from the stoma.

Another day there were two cases of direct transfusion of blood. The first was one of advanced lymphatic leukæmia, and in this a large amount of the patient's blood was removed by venesection at the same time that she was receiving blood from the donor. The second case was one of post-partum hæmorrhage of a very severe type. The donor was a young man of thirty, who was related to the patient. When no relative can be obtained as a donor, it is usual to offer 40 francs to a stranger, but more often than not the service of giving blood is done from sentiment rather than for money. The technique is delightfully simple. Only stovaine skin anæsthesia is used for both recipient and donor. The radial artery of the donor is connected to a vein in the arm or leg of the recipient by means of a short metal tube which is kept stored in liquid vaseline. The transfusion is allowed to proceed for about twenty-five minutes, the blood-pressure of both persons being observed at frequent intervals. In reply to a question as to any tendency of the blood to clot in the metal tube, Tuffier stated that the vaseline prevented this, and in one case, at the end of twenty minutes, he demonstrated the blood flowing in a full stream from the end of the tube when it was disconnected from the vein of the recipient.

On alternate days to those for operation, Prof. Tuffier makes a teaching clinical round. The wards present a condition of great congestion, the beds being placed so close together that there is barely room to walk between them, the whole of the centre space being fully occupied. He is accompanied sometimes by his assistant, and always by several of the house surgeons and a class of about ten men and eight lady students, several of the latter not being medical students, but merely society ladies studying for the voluntary Red Cross Society service.

The students read notes, and they are very closely questioned by the Professor, who constantly illustrates his remarks by drawing with chalks on a large slate, on the sheet, or on the patient's abdomen.

The whole party are clad in white overalls, and the surgeon and house surgeons wear thin rubber gloves all the time.

There is a happy innocence of all rules of propriety in examining and exposing patients, which greatly simplifies teaching a big mixed class in a crowded ward.

The special subjects which now claim the attention of Tuffier and his service, are the grafting of tissues and organs, and the operative treatment of abdominal ptosis.

In one patient from whom the ovaries and uterus had been removed for a fibroid in 1909, one ovary had been re-implanted in the abdominal wall between the fascia and the skin, and this could readily be felt as a tender swelling about the size of a walnut. He has done over 150 of these cases of re-implantation of ovaries, but he now usually places the organ between the muscle and the peritoneum.

On various occasions, when special cases require it, a consultation is held with the radiographer or physician, and these afford in their animation a most instructive discussion for the benefit of the students. Tuffier's eloquence and humour, as well as his unceasing acts of daring and resource, make him evidently the object of no little hero worship by those who follow in his train.

In conclusion, we express our sincere thanks to Professor Tuffier for his great kindness and courtesy extended during the visit to his clinic, and in the preparation of this short and very inadequate notice.

INSTRUCTIVE MISTAKES.

CASE 1.

ACID INTOXICATION MISTAKEN FOR INTUSSUSCEPTION.

D. B., aged 5, was a bright, fat, and healthy girl, who had had no previous illness. She came of a healthy family, but the mother had suffered for many years from typical membranous colitis.

March 27, 1905. The child was taken with what appeared to be a simple "bilious attack," for which the circumstance that she had lately surreptitiously eaten a large quantity of chocolate was given as the cause. The bowels were opened after a mild purgative, and it was noticed there was some mucus in the stools. The vomiting continued in spite of this, occurring in small quantities every few hours. She was restless and uncomfortable, but had no definite pain or tenderness.

April 1. The condition described in the last note had continued with very little alteration. Vomiting incessant, with no special relation to food. Mucus passed by rectum after an enema, but no fæces. Mental condition was drowsy and lethargic, the tongue was furred, and the breath mawkish.

April 2. The condition having remained unchanged, a consultation was held with an eminent physician. The abdomen was decidedly full but not rigid, and the child's natural obesity made it difficult to say whether there was any distention. An elongated resistance could be felt below the right costal margin, and this was thought to be an intussusception. The urine showed no sugar or albumin.

April 3. A second consultation was held with a surgeon, who agreed that the case was probably one of intussusception, or at any rate some form of intestinal obstruction, and advised that an exploratory operation should be done without delay. The pulse and temperature from the outset of the illness had not risen above normal.

Operation (April 3, 1905).—Anæsthetic, open ether and chloroform. Median incision. Nothing abnormal discovered except that the liver was rather large and fatty, and it must have been the lower margin of this that was felt below the ribs. The operation was badly borne, and strychnine had to be administered before the end. The child remained in a drowsy condition, with incessant vomiting, until her death, which took place on the evening of the next day. The pulse became feeble and rapid (144), and the temperature rose steadily to 103·4 before death.

Autopsy.—No organic disease of any kind was discovered by a complete post-mortem examination, beyond the fact already noted of the large, fat liver. A small quantity of urine was in the bladder, and it gave the reactions of both acetone and diacetic acid.

There are several points about this case of great practical importance. After the event, it was easy to see that the combination of drowsiness and vomiting with sweet-smelling breath ought to have led to the suspicion of acid intoxication, which could easily have been confirmed by the examination of the urine for the acetone bodies. But at the time, unfortunately, this idea did not present itself, and the vomiting, passage of mucus by the rectum, abdominal fullness, and sausage-shaped swelling, all suggested the diagnosis of intussusception. The absence of colicky pain ought, however, to have given us warning, and it did indeed make us think that the case was unusual. But the rule which applies to most cases of suspected intestinal obstruction, viz., that it is less dangerous to open the abdomen than to delay, was in this case a fatal mistake. For whatever the nature of the metabolic change which brings about acute acidosis may be, there is no doubt that either the traumatism of a big operation, or the administering of a general anæsthetic, particularly chloroform, will aggravate it to a fatal issue.

CASE 2.

INTUSSUSCEPTION MISTAKEN FOR ONE OF INFANTILE ENTERITIS.

William S., aged 10 months. Admitted on August 1, 1912, for diarrhœa and vomiting. On admission the child was rather collapsed and blue; temperature 97°; pulse 130. The child was constantly crying as if in pain. Motions, three or four each day, were greenish, with a little blood and mucus. Vomiting occurred after each feed. A provisional diagnosis of gastro-enteritis was made. Ten drops of brandy and quarter of a grain of calomel were given every four hours during the first day. From August 2nd to 6th the condition remained much the same as in the last note. The stomach and rectum were washed out twice a day, and a mixture containing bismuth and salol was administered. The stools continued to be loose, and contained both mucus and blood, but were never more frequent than four each day. It was noticed for the first time on August 6, that the abdomen was distended, and the child was transferred to the surgical side of the hospital. On its arrival there the condition was very grave: pulse 160; respirations 40; temperature 96; the child being blue and cold. A rather indefinite resistance was felt above the umbilicus. Diagnosis of intussusception was made, and immediate operation resorted to.

Operation (Aug. 6, 1912).—Median incision. The common type of ileo-colic intussusception was discovered, the apex of the intussusceptum being in the upper part of the descending colon. A reduction was easily effected, and the operation was concluded by performing an appendicostomy through a stab wound. By means of a catheter tied in to this a continuous saline was administered, but the child died twelve hours later.

There can be no doubt that if the nature of this case had been recognized when the child was first admitted it would have had a very good prospect of recovery. Even after five days, and in spite of drugs and purgatives, the invagination of the bowel was readily reducible. The child died as the result of the constant vomiting after food which had continued for six days. The fact

that the abdomen showed neither distention nor tumour during the first four days was due to the fact that complete obstruction did not exist. The principal feature which might have prevented this mistake was the scanty nature of the stools. In a case of gastro-enteritis the motions are usually very much more numerous than three or four a day. In this case, although they were only few in number, each stool contained both blood and mucus. Enteritis, on the other hand, rarely causes blood in the stools unless the diarrhœa is very severe.

CASE 3.

INTERNAL HÆMORRHAGE FROM A DEEP EPIGASTRIC VEIN IN A HERNIA OPERATION.

Frederic P., aged 42, a labourer, was admitted to the hospital for double inguinal hernia which had been in existence for about two to three years. He was a thin spare man, with the lax abdominal wall which is associated with certain types of hernia. There was a direct inguinal hernia on both sides, neither of which descended into the scrotum.

Operation (Sept. 9, 1912).—The left side was operated upon first in the ordinary way. The sac had a broad base, and it was pulled well out of the abdomen, clamped with two forceps, and the cut edges sewn together. Otherwise the usual Bassini operation was carried out. The right side was similarly treated, and on separating the structures of the cord from the sac and opening the latter, there was a good deal of free blood. It was naturally thought that this came from one of the spermatic veins, and some time was spent in searching for a wounded vessel. At last it was noticed that the blood was really welling up from the abdomen through the neck of the sac, and at the same time the anæsthetist complained that the patient's pulse was becoming rapid and weak. As it was probable, but not certain, that the intraperitoneal hæmorrhage arose from the left operation area, the abdomen was opened by a median incision. The pelvis was full of venous blood, and on mopping this out, the bleeding was found to proceed from one of the deep epigastric veins on the outer extremity of the sutured hernial sac. It was readily secured from within the abdomen, the median incision closed, and the operation completed on the right side. The patient made a good recovery.

This severe internal hæmorrhage from one of the deep epigastric veins is an accident the origin of which is easy to understand. The direct hernia had a broad-necked sac, and in pulling this up so as to remove the redundant peritoneum completely, the epigastric vessels must have been lifted up and either cut or torn by the forceps.

It is not so easy to explain why the hæmorrhage was into the peritoneum rather than into the tissues of the wound, as the vessel lies outside the peritoneal cavity. The suture which occluded the neck of the sac must have missed its outer part, together with the wounded vein. The conjoined tendon sutured to Poupart's ligament in front of the neck of the sac, prevented the blood from appearing in the wound. It was very fortunate that in this case the necessity of operating on the other side revealed the presence of the internal hæmorrhage; otherwise the issue might well have been a fatal one.

CASE 4.

HÆMORRHAGE FROM A RUPTURED ILEOCOLIC ARTERY IN THE OPERATION FOR ACUTE APPENDICITIS.

Charles W., aged 35, an ironworker. Admitted to hospital with a typical condition of acute appendicitis. He gave a history of three previous attacks, each of about a month's duration, during the past two years. The present attack began three days previously, with abdominal pain and vomiting. A perfectly definite tender mass could be felt low down in the right iliac fossa.

Operation (Nov. 4, 1912).—Abdomen opened by a gridiron incision, and an indurated mass exposed formed by the cæcum, behind which lay the appendix, pointing almost directly upwards. The appendix was almost entirely gangrenous, and the parts around were infiltrated by inflammatory œdema, but there was no pus. The posterior position of the appendix and the induration of its mesentery made it necessary to pull the cæcum downwards and forwards in order to complete the operation. When this had been done in the usual way, bright blood was found to be welling up from the depths of the wound. No amount of swabbing through the widely retracted incision revealed the source of the bleeding, and it was necessary therefore to cut through the transverse muscles of the abdomen upwards parallel to the semilunar line.

It was found that the traction on the cæcum had torn a large hole in the root of the mesentery, and the ileocolic artery had been ruptured in its terminal part. The bleeding vessel was secured, the hole in the mesentery sewn up, and the wound closed, with drainage. Recovery was uneventful; the drain was removed four days later, and the patient left hospital in four weeks.

The explanation of this accident is readily given. The inflammatory induration, originating in the appendix, had extended to the root of the mesentery, rendering this so friable that it was readily torn by the traction upon the cæcum. It is probably wiser in a case of plastic appendicitis to open the abdomen freely by a simple oblique incision, rather than to employ the gridiron opening, which necessitates traction upon the cæcum for the exposure of a posteriorly situated appendix.

SHORT NOTES OF RARE OR OBSCURE CASES.

A CASE OF POLYCYSTIC DISEASE OF THE PANCREAS.

By R. F. BOLT, Bristol.

Mrs. S., aged 51, was admitted into the Bristol General Hospital on February 18, 1913, with the following history :—

Six months previously she noticed a swelling in the abdomen, just above and to the right of the umbilicus. Shortly afterwards she had attacks of abdominal pain which often made her faint ; she became very weak, and took to bed. She then began to vomit two or three times a week, as a rule directly after taking food, and the vomiting continued up to the time of admission into the hospital. The vomiting relieved her pain. She had never noticed any blood in the vomit. For the last three months she had been getting more and more constipated, and she had been losing weight.

Condition on Admission.—Patient was emaciated. Pulse 80. Respiration 20. Temperature 98·6°. Abdomen : Coils of intestine could be seen, and there was a hard nodular tumour to be felt just above and to the right of the umbilicus, and a second nodular mass was felt in the left part of the epigastrium. A third tumour could be felt below the right costal border which worked with respiration and could be grasped between the hands placed in the loin.

A test meal was given, with the following result : Total acidity 0·053 per cent, combined HCl 0·050 per cent, free HCl 0·007 per cent ; no lactic acid.

Urine : acid, sp. gr. 1020 ; no albumin ; no sugar.

An Operation was performed by Mr. Hey Groves on February 21. A median incision was made extending from the ensiform cartilage to the umbilicus, and the peritoneal cavity opened. Immediately, a large nodular and cystic tumour was seen projecting over the lesser curvature of the stomach. The tumour was found to be contained in the lesser sac of peritoneum, which was opened. The tumour was then easily brought out of the abdomen, and from the shape and anatomical relations, was found to be the pancreas. The whole of the organ was polycystic, the cysts varying in size from a cherry-stone to a currant, those in the body and head being larger than those in the tail. No normal pancreatic substance could be found. Examination of the right kidney showed that it too was polycystic, the upper pole consisting of six or seven cysts ; the lower part of the organ appeared to be normal. The stomach, liver, and left kidney were normal.

The abdomen was closed without further operation.

Clinically this case presented a very close resemblance to one of cancer of the stomach. There were pain, emaciation, and vomiting, with the formation of epigastric tumours. The tumour above and to the right of the navel resembled

a malignant pylorus; that under the left costal margin suggested a secondary growth in the left lobe of the liver; whilst that in the loin might have been a large mass in the right hepatic lobe.

That the growth was not a nodular carcinoma was evidenced by the fact of its extraordinary mobility. The body of the pancreas could be lifted outside the thin abdomen without any tension, and it would have been quite easy to remove the whole mass if this had been desirable.

It is of course well known that in polycystic disease of the kidneys there also sometimes occur a few cysts in the liver, spleen, or pancreas. But in this case the affection of the pancreas was much more marked than that of any other organ, although the cysts of the right kidney afforded evidence of the relation of this case to the more usual type of disease.

After the laparotomy, with suitable diet the patient's condition improved, the pain and vomiting ceased, and she began to gain in weight. She was given liq. pancreaticus 1 dr. t.d.s. Examination of the stools before and after the operation showed that they were normal in colour and consistency. No excess of fat was present.

At no time was sugar found in the urine, and she passed on an average thirty ounces a day.

My thanks are due to Mr. Hey Groves for being permitted to publish this case

---

AN UNUSUAL CASE OF SYNDACTYLISM.

By ERNEST W. HEY GROVES, Bristol.

William B., aged 51, was admitted to the General Hospital suffering from an accident, caused by falling off a ladder.

He was born with a deformity of the left hand, the middle and ring fingers of which were united. An attempt was made during infancy to separate these fingers, unsuccessfully. The skiagram (*Fig.* 62) shows a remarkable disarrangement of the bones. The middle finger is short and fused intimately to the fourth finger. It has only two phalanges, the middle one appearing to be absent. Between the knuckles of the first and second fingers there is a stout dumb-bell-shaped bone which acts as a strut connecting the heads of the metacarpals, which are separated by a wide interval. The hand is quite strong and useful.

Fig. 62.—Syndactylism.

It is curious that whilst there is one phalangeal bone absent, a supernumerary bone is present, placed transversely. Possibly the latter represents the proximal phalanx, which has become displaced

A CASE OF ABSENCE OF BOTH FIBULÆ, WITH CERTAIN OTHER DEFORMITIES.

By ERNEST W. HEY GROVES, Bristol.

Baby Williams, age 9 months. The child was brought to the Hospital first when it was a week old. It was a full-time child, and of good general development. There were no other children. The appearance presented by both legs was remarkable. At the junction of the middle and lower third of each shin, the bone was sharply angulated, as though it had been broken, and at the point where the angle of bone pressed against the skin there was a dimpled scar. This condition was exactly similar in both legs. It strongly suggests that a compound fracture had taken place in utero, but it is held by some authorities to be caused by amniotic adhesions.

Fig. 63.—Skiagram showing the legs from the front.

It was not possible to obtain a skiagram on the first occasion, as the child could not be kept still. Nine months later, however, the accompanying skiagrams were taken. *Fig.* 63 shows that both fibulæ are completely absent. In the right foot there are two tarsal bones ossified, in the left only one. It is difficult to say whether the large tarsal bone is the os calcis or the astragalus. In each case it lies at the outer side of the lower end of the tibia, and the foot presents an extreme valgoid deformity.

Two toes are absent from each foot, probably the two outer, corresponding to the absence of the outer bone of the shin, the fibula.

In *Fig.* 64 the angulation of the lower part of the shaft of the tibia is seen, but is much less marked than it was shortly after birth. In this lateral picture, in the left foot the large tarsal bone resembles the os calcis, giving distinct evidence of the sustentaculum tali.

Fig. 64.—Skiagram of the legs—lateral view.

NEW INSTRUMENTS AND APPLIANCES.

A PORTABLE OPERATION THEATRE.

By G. H. COLT, Aberdeen.

The following proposal for a portable operation theatre is made tentatively, because the idea is believed to be new and the advantages it offers may not be sufficient to warrant a large outlay on experimental work. Briefly, the scheme provides a portable motor operation theatre which could be taken to the patient's house and to which he would be carried for operation, in much the same way that he would be to an ambulance, and from which he would be removed to bed at the conclusion of the operation. At present, when a journey has to be made by train and the case is one involving the use of the Trendelenburg position, a portable operation table has to be carried; this, together with the sterilizer, instruments, bowls, ligatures, anæsthetist's apparatus, and the drums containing the towels, gowns, and dressings, is troublesome luggage to transport from the surgeon's house to the train, from the train to the patient's home, and back again after the operation has been performed. At the patient's residence, a room has to be cleared, sometimes the dust is raised, and the apparatus has to be unpacked. Household arrangements are much upset, and occasionally carpets and furniture are soiled. With a portable theatre, the surgeon would be sure that the arrangements, especially as regards light, would be better than he could obtain in a house at short notice. The proceeding would, of course, not be suitable for a busy thoroughfare. If objections were urged after arrival on the ground of publicity, the necessary apparatus could be taken into the house and the operation performed as usual. In most cases, however, the facilities available would be known beforehand.

For municipal or state service, or for military work the scheme is ideal. It might not be possible, or prudent, to take the theatre to the actual scene of operations, but it could be taken fairly near, and if motor transport failed other kinds could be used, provided the body of the theatre could be detached from the wheels.

For private use the obvious objections are (1) Bad roads, (2) Publicity, (3) Excessive weight of a patient, (4) The amount of capital locked up.

It will be seen that two alternative plans are suggested, the second being a modification of the first, chiefly in respect of the interior arrangements and disposition of the furniture. The first alone is illustrated in the accompanying diagrams, but the second can easily be imagined.

The size of the theatre inside is: Length 9 ft. 6 in., width 5 ft., height 7 ft., but experience may lead to slight alterations in these dimensions. Ventilation is by windows and an electric fan. The floor is mounted on the chassis as low as is consistent with rapid transit and the regulation width between the wheels.

If necessary, some of the floor space at the sides may be taken up for this purpose, as is done in an ambulance. The portion of the floor between the door and the central support of the operation table, measuring 3 ft. 6 in. long by 4 ft. 6 in. wide, is recessed 3 in. deeper than the rest. This space is filled by a double sliding piece which can be pulled out and let down to form a sloped ascent to the theatre 6 ft. long and 4 ft. 6 in. wide, and is provided with central supports and side braces. The walls are finished outside to resemble the body of a motor car or, for military purposes, "Red Cross." Inside they are lined with a thin layer of sheet asbestos, "Poilite," or other suitable material, enamelled white. The space between is lightly packed with asbestos wool, and all pipes and cables are carried in it. All are in duplicate, and by means of detachable panels can be easily reached should they become deranged. There are two windows of frosted glass in each side wall. Each is 2 ft. 6 in. long and 1 ft. 3 in. wide, and extends upwards from a spot 4 ft. from the floor. Each is supported below by a lazy-tongs spring and has a handle near the top. There is also a window at each end. The roof is raised in the middle line and slopes to each side to provide for water draining off both from the outside and the inside. The greater portion of the roof is constructed of plain frosted glass electro-welded by the "Luxfer" process. It carries five electric lights, arranged two over each end of the table and one in the middle. The last is always present, but Osram burners being used for the other four, they are removed for travelling and placed in position when required for use. The wiring is in duplicate. Electricity is supplied from a double set of accumulators connected with a dynamo worked from the engine.

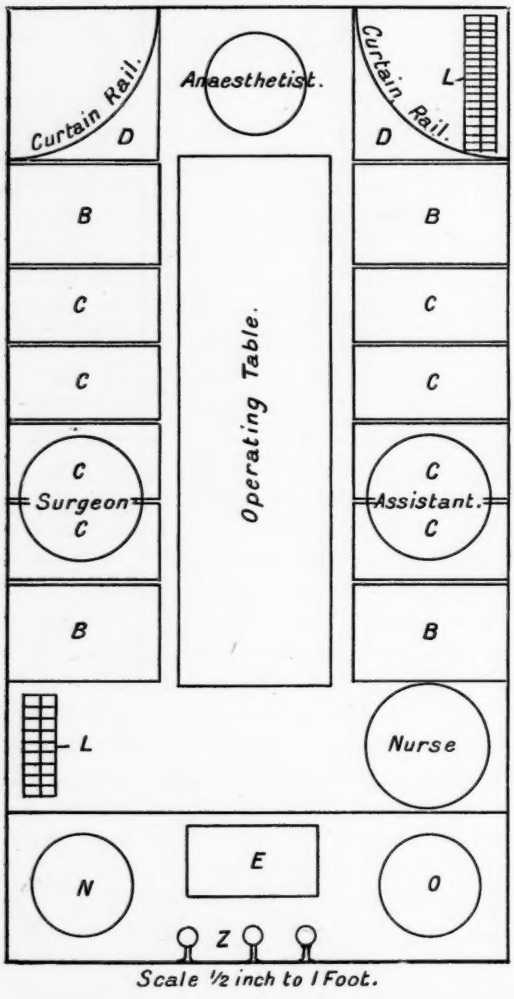


FIG. 65.—GROUND PLAN.

B. Large flap tables. *C.* Small flap tables. *D.* Anæsthetist's tables. *E.* Sterilizer. *L.* Radiators. *N.* Hot sterilized water. *O.* Cold sterilized water. *Z.* Various fittings.

The operation table is mounted on a fixed central support with oil-pump mechanism for raising and lowering. The head end is towards the front of the

car. The height for ordinary work is assumed to be 3 ft. A canvas stretcher and poles are provided, and a piece of webbing with buckle to prevent the knees of the patient from moving during the induction of anæsthesia. The supports for the head and foot of the table are fixed to the base of the central support, and each is adjustable by a sliding rod and clamp tube as in Paul's table, or by other suitable means. The anæsthetist's stool is fixed to the floor by fly-screws for travelling.

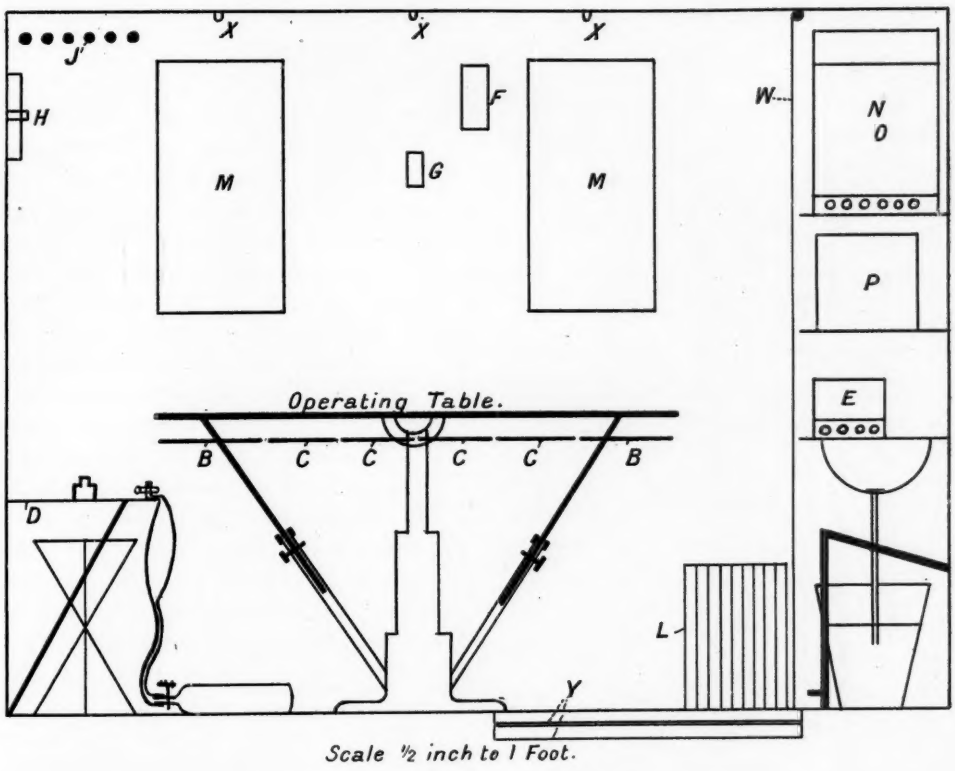


FIG. 66.—SIDE VIEW.

B. Large flap tables. *C*. Small flap tables. *D*. Anæsthetist's tables. *E*. Sterilizer. *F*. Irrigator. *G*. Wall plugs and switches. *H*. Fan. *J*. Coat pegs. *L*. Radiator. *M*. Windows. *N*. *O*. Sterilized water. *P*. Drums. *W*. Roller blind. *X*. Electric light. *Y*. Sloping ascent.

The walls are fitted with tables which, when not in use, can be closed up flat on their hinges against the walls, and are held in this position by spring clips and rubber dams. When in use they are lowered, and a central support in each fits into a cup formed in the angle between the wall and the floor. Twelve of these tables are provided for the operator and his assistant, six on each side. Each when lowered projects 1 ft. 6 in. from the wall. The four end ones are each 12 in. wide, and the others 9 in. wide. All are the same height, the tops being 33 in. from the floor. It will be seen at once that, by bringing the tables into combination any desired accommodation may be obtained, according to the position of

the operator and his assistant. If necessary, a bridge table may be placed across the patient from a table on one side to one on the other. The anæsthetist is provided with tables similar to the operator's, one on each side, but of a different size, and the tops are 26 in. from the floor. He is also provided with a series of spring clips holding metal cases for his bottles. The gas cylinders are placed under his right-hand table, and securely fixed to the floor for transit.

The warming of the theatre and entire apparatus is by superheated steam, generated near the engine by means of a petrol vapour or other burner and boiler. It is possible that the makers of the car would advise the use of steam throughout, i.e., the employment of a steam car. It seems to me that steam would be better than electricity for heating purposes. A naked light cannot be employed inside the theatre because of the production of phosgene gas from the chloroform vapour, and because of the risk of explosion when open ether is used.

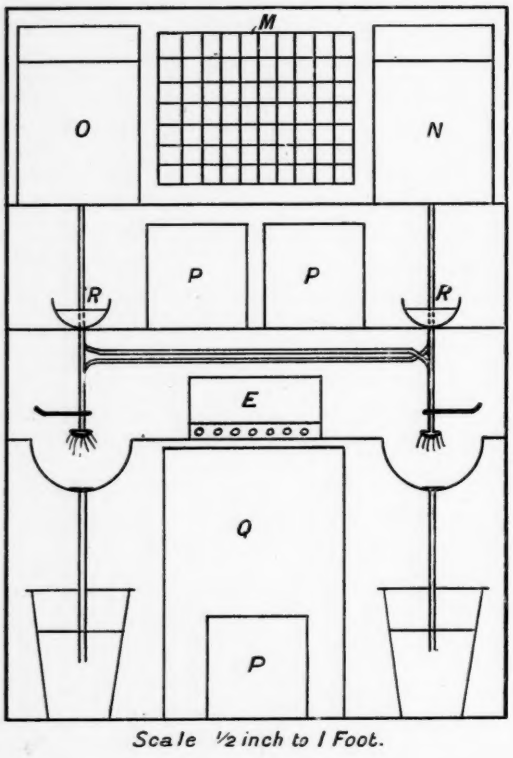


FIG. 67.—END PLAN.

E. Sterilizer. *M*. Window. *N*. Hot sterilized water. *O*. Cold sterilized water. *P*. Drums. *Q*. Stores. *R*. Hand lotion.

In the first scheme the rear part of the car for a length of 1 ft. 6 in., and for its whole width, is detachable like a door, and swings out on hinges securely built into the frame. The handle to open it is a wheel, and can be operated either from within or without. It is so devised that before the door can be opened a wheel must be lowered on to the ground to support the weight at the handle end of the door. This wheel is normally carried some 9 in. off the ground, and is raised and lowered by rack-work. When it is at its lowest point, spurs attached to the rack-work register with slots in the side of the car and allow the door to be opened. Just before this is done the spurs are turned so as to engage corresponding slots in the door and fix the supporting wheel to it in its lowest position. The fittings attached to the door are shown in *Fig.* 67. When the door is open they are hidden by a roller blind. The steam pipes are hinged to correspond with movements of the door in the same way that they are hinged to a movable radiator.

Sterile water is prepared and allowed to cool in the sterilizer provided. Sterile hot water is prepared on the journey, and the instruments are boiled then or after arrival. Drums of dressings, etc., are shipped before starting. All vessels likely to contain water are divided up inside, so as to "baffle" movement

during transit, and all articles or fittings likely to rattle are secured by spring clips and rubber dams.

The alternative arrangement consists in placing the apparatus shown in *Fig.* 67, at the driver's end of the car, replacing the special door previously described by two ordinary doors, and having the foot of the operation table towards the front of the car. This is the arrangement of choice, and is much the better mechanically speaking, but it might result in the patient's head being unduly lowered after an operation for peritonitis. It seems to me that this objection could be overcome, and that it will only arise if the distance between the floor of the car and the ground is greater than is usual in an ambulance.

It is proposed that the car shall carry, in addition to the chauffeur, the surgeon and his assistant, the anæsthetist, and a nurse. The four last mentioned would sit on collapsible chairs, which are folded and removed before the operation. On arrival, the chauffeur would select the most convenient spot for the car, open the door, fold and remove the chairs and let down the sloping ascent. He and the assistant would take the stretcher to the room of the patient, who would be placed on it with his body and face covered. He would be carried down and placed in the theatre. The poles would be removed, the sloping ascent replaced, the door closed and bolted, and the roller blind drawn up. The strap would be adjusted across the patient's knees, and the anæsthetic commenced. The surgeon and all concerned would remove their coats and hats and place them in the recess for the purpose. They would wash up, put on their gowns, etc., and get into position. The flap tables suitable to the case would then be lowered, covered with sterile towels, and in a few minutes the operation could be commenced. When completed, the reverse process would be carried out, and, if necessary, the theatre disinfected by means of a formalin vapour lamp.

At first sight there appears to be no obvious difficulty in carrying out this invention, and it is hoped that a surgeon, the nature of whose practice warrants the experiment, will see his way to make use of it.

REVIEWS AND NOTICES OF BOOKS.

The Surgery of the Stomach. By HERBERT J. PATERSON, M.A., M.C., M.B. (Cantab), F.R.C.S., Hunterian Professor Royal College of Surgeons, Surgeon to Out-patients London Lock Hospital. London: James Nisbet & Co. Price 12s. 6d. net, with plates.

MR. PATERSON'S latest contribution to the literature of gastric surgery is designed to present in a practical form the methods of diagnosis and treatment of those affections of the stomach which are amenable to direct surgical interference.

As might be expected, the author devotes considerable detail to the chemical investigation of the gastric contents after the ingestion of test meals. Mr. Paterson rightly points out that in order to draw conclusions of any value it is essential that the test meal should be a standard one. The author has devoted much care and attention to this subject, and there is a possibility that with further investigation gastric analysis may come to occupy something more than a very subsidiary place in diagnosis. After a description of the methods of investigation of gastric cases, the author deals with pre-operative treatment and the various operations which are performed on the stomach.

The greatest amount of attention is naturally devoted to the operations of gastrojejunostomy and gastrectomy. With regard to the former, Mr. Paterson usually performs the posterior operation, although he still adheres to the opinion that there is nothing to choose between the anterior and posterior methods so far as the ultimate results are concerned; in this view we think he is at variance with most surgeons of wide experience.

He describes both operations in detail, and the descriptions are illustrated by a number of very excellent photographs which were taken by Dr. Howard Kelly. It seems a little unnecessary to repeat the description of the method of suture and to reproduce seven of the photographs twice.

The technique of the operation of gastrectomy is similar to that described by W. J. Mayo (*Jour. Amer. Med. Assoc.*, 1910, liv, p. 1608). The most important modification suggested is that gastrojejunostomy should be performed before the resection is undertaken; the reasons adduced for this procedure have some weight, but it is probable that they are of less importance than the risk of placing the anastomosis too near the pylorus to allow of adequate removal. The author devotes little space to the operations of excision of ulcer and jejunostomy, and is of opinion that the indications for their performance are very limited.

An interesting chapter is devoted to the "Physiological effects of Gastro-jejunostomy," and the arguments in support of the contention that the beneficial results of operation are largely due to alterations in the gastric secretions and not merely to drainage will no doubt receive the support of many surgeons.

The symptomatology and differential diagnosis of gastric and duodenal ulcer are treated in considerable detail and the operative indications discussed. Mr. Paterson expresses very strongly the opinion that the excision of chronic ulcers on the lesser curvature and near the cardia is an unnecessary operation, and states that his results from gastro-enterostomy in these cases are more successful than for any other condition, and that all the patients upon whom he has performed the operation are perfectly well. Whilst we are entirely at one with him in his contention that excision of the ulcer does not influence the morbid condition, whatever that may be, which was responsible for the origin of the ulcer in the first instance, and that recurrence of ulceration may occur at the site of excision or in other situations, there is equally no doubt that many surgeons who have had the greatest experience in gastric surgery have found that gastrojejunostomy alone, in ulcers of the lesser curvature

and cardia, has been followed by disappointing results. It is possible that a combination of the two operations will prove to be the solution of the difficulty.

In cases of perforation, the author advocates the routine performance of gastro-enterostomy. The arguments Mr. Paterson produces are not convincing, and he furnishes us with no record of the result of his practice.

Among the other complications of ulcer, hæmorrhage and gastric tetany are considered. With regard to the former, Mr. Paterson states his belief that in cases of duodenal ulcer, hæmorrhage occurs most frequently from the gastric mucosa and not from the ulcer itself; the evidence upon which he appears to base this conclusion is but slender, and he offers no explanation of the fact that profuse melæna is so much more frequent than profuse hæmatemesis. We would suggest that the operative indications in hæmorrhage from a duodenal ulcer are entirely different from those in the case of a gastric ulcer, and that hæmorrhage in the former is an absolute indication for operation without waiting for any second attack.

With respect to ulcus carcinomatosum, Mr. Paterson questions the conclusions drawn by Drs. Wilson and McCarthy as to the frequency with which carcinoma arises in chronic ulcer, but the results of the careful and painstaking investigations which these pathologists have made into a very large number of specimens are not seriously affected by the kind of argument which he brings forward.

A strong appeal is made for the earlier diagnosis of carcinoma, and the clinical aspects of the disease are very clearly described. The indications for, and limitations of, resection are discussed, and with his conclusions we entirely agree.

The mimicry of peptic ulcer by chronic lesions of the appendix is treated at some length in the chapter on "Appendicular Gastralgia," and there is much to be said for the contention that chronic inflammatory lesions of the appendix may be a factor in the etiology of gastric and duodenal ulcer; further investigations in this direction may lead to important results.

The illustrations are excellent, and there is a most complete and useful bibliography.

We are bound to confess that the impression which Mr. Paterson's book has made upon us is one of disappointment. A spirit of healthy scepticism in medicine and surgery makes for progress, but before we are prepared to accept many of the author's views he must support them by detailed and accurate evidence.

Practice and Problem in Abdominal Surgery. By A. ERNEST MAYLARD, M.B., B.S. Lond.; Surgeon Victoria Infirmary, Glasgow; Examiner in Clinical Surgery Conjoint Board, Scotland. J. & A. Churchill. Pp. xiv. and 380, with 39 illustrations. Price 12s. 6d.

THIS is an entirely original book on original lines. The author, whose surgical experience dates back to 1880, in the days when abdominal surgery was in its infancy, has already published a work on the surgery of the alimentary canal, which was largely a compilation of the work of others. The present volume, on the other hand, is based entirely on the personal experience of the writer. It does not attempt to deal in a systematic manner with the surgery of the abdomen. It presents rather a series of problems, some of which the author has solved and others which he has not. The following selected subjects will give an idea of the scope of the book. Abdominal pain, its origin and nature; exploratory operations, their scope and indications; peritoneal adhesions; the relation of the stomach to other abdominal viscera; the diagnosis between functional and organic diseases of the stomach; the cause of gastric pain; the rôle of spasm in producing pyloric obstruction; the problem of the "acute abdomen."

The whole is written in a spirit of scientific inquiry, with a complete absence of mere dogmatic assertion. This makes it both interesting and stimulating to read. Those who do not agree with Mr. Maylard's conclusions will nevertheless feel indebted to him for presenting various problems with his own solution of the same as a basis for further discussion.

A strong case is made out for more frequent use of transverse abdominal incisions. In the after-treatment of his cases, the author regards four weeks as the ordinary

time to be spent in bed by a patient in whom the wound has healed by first intention. He is quite unconvinced of the value of the shortened bed-period which most surgeons have adopted. Iodine is seldom used for skin preparation, because of its irritating properties.

The description of technique is marked by a want of logical consistency, which is illustrated well by *Fig.* 16, in which all five nurses are capped and masked, but the operator and his assistants are without this protection. Further, the use of gloves is deprecated for what seem to us wholly insufficient reasons.

In the most interesting discussion of gastric surgery, some of the points which arrest attention are the importance attached to spasm and the narrowing of the pyloric orifice as distinguished from organic disease, and the scepticism about the value of anchoring up a prolapsed stomach. The so-called " no loop " gastro-enterostomy, as shown in *Fig.* 27, appears to have a very long loop, and the bowel is acutely bent just beyond the stoma. In operating for a bleeding duodenal ulcer, closure of the pylorus is emphasized as being necessary, in addition to short-circuiting. The discussion of the diagnosis of both acute and chronic abdominal lesions is very good, but would be made more complete if it were clearly pointed out how those conditions may be recognized in which an operation is useless or harmful.

SHORT NOTICES.

An Operating Theatre in Private Practice. By C. HAMILTON WHITEFORD, M.R.C.S., L.R.C.P., Plymouth. London: Harrison & Sons. Pp. 76. Price 3s. 6d.

THIS small book is a careful description of a recently erected operating theatre, with the accessory suite of rooms, attached to a private nursing home. It gives a valuable and practical account of the equipment of such rooms with regard to both up-to-date technique and economy in construction. Its value would be greatly increased by illustrations and a statement of the cost of construction.

Diseases and Injuries of the Eye. A Text-book for Students and Practitioners. By WILLIAM GEORGE SYM, M.D., F.R.C.S., Ophthalmic Surgeon, Edinburgh Royal Infirmary. A. & C. Black. Pp. 493. Figs. 87 and Plates xxv, many in colours. Price 7s. 6d.

THIS book is an excellent up-to-date presentation of the subject written for the student and practitioner rather than for the specialist. Thus the operations upon the eye and orbit are summarized in a simple manner so as to be included in fifty pages. On the other hand, the subjects of medico-legal eye questions, general diagnosis, eye symptoms in general diseases, and the nursing of ophthalmic cases, are fully dealt with. The small figures are very clear, and the plates are of a high order of artistic merit.

A Text Book of Midwifery: for Students and Practitioners. By R. W. JOHNSTONE, Assistant to the Professor of Midwifery in the University of Edinburgh. A. & C. Black. Pp. 485. Figs. 264. Price 10s. 6d.

THIS is a compact and useful text-book for the use of students. The greatest attention is given to points of practical importance, e.g., the after care of the infant, and the ordinary operations of obstetric practice. The numerous illustrations are clear and diagrammatic. The text is so arranged by the use of special type, headings, and sub-sections as to give a very clear classification of the various parts of the subject.

JOHN HUNTER.

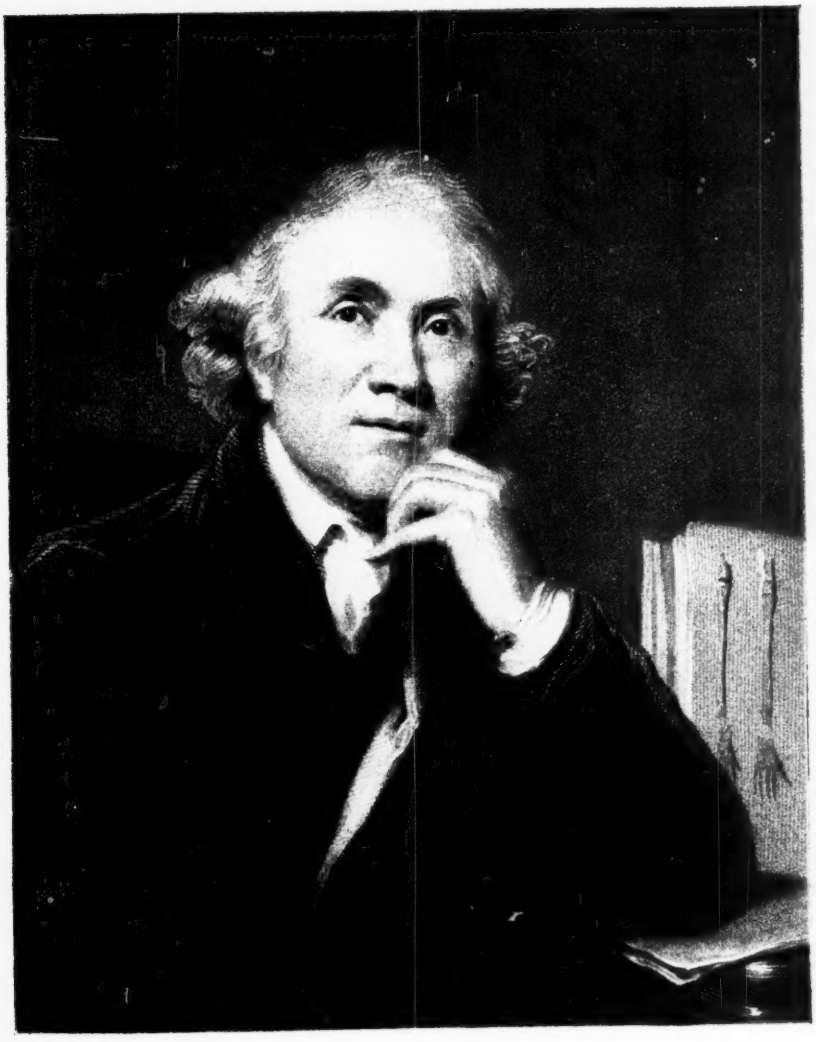
1728-1793.

If Lister may be looked upon as the maker of the finished product of scientific surgery, Hunter certainly worked the raw material. Surgery had no scientific basis before Hunter. He collected the facts, collated the data, and left the broad platform upon which his pupils raised that building which subsequent advances brought to its present state—modern surgery. Hunter was admirably equipped for his purpose. Uneducated—or rather, self-educated—Nature had endowed him with indomitable patience, inexhaustible curiosity, and very remarkable acquisitiveness. The accident of his brother William's position in London made him a surgeon at a time when the practice of surgery was dependent upon the teaching of anatomy by dissection. The lack of early education was both helpful and harmful: helpful, because it made him examine everything for himself, not knowing what had already been done by others; harmful, because it limited his powers of expression both in speaking and writing. The fertility of his genius was thus rendered less prolific, and the conclusions at which he arrived were occasionally marred by that failure of logical processes which a better education might have prevented. He lived at a time when coarseness and roughness were characteristics of the English nation, for the polish of Queen Anne's reign had not yet been succeeded by the refinement of the later years of George the Third. Such manners served John Hunter's purpose well. They enabled him to sweep away at once the old bases of hypotheses upon which the practice of surgery had been erected, and to clear the ground for the new building. But he was not without refining influences, for he married a handsome, clever, and agreeable woman, who was an accomplished musician and made a name for herself by supplying the words for Haydn's "Creation." In his public capacity as a teacher he attracted the best of the younger generation of surgeons in both hemispheres, men who afterwards proved themselves the master minds of the profession, and exerted themselves to establish his theories and advance his conclusions. Edward Jenner, Cline, Abernethy, Astley Cooper, Physic and Thomson were members of this noble band, *et quasi cursores vitai lampada tradunt.* Joseph Henry Green and Lawrence, Warren and Gross carried on the work, and from their instruction came a Paget and a Savory.

Reynolds' portrait makes it easy to see John Hunter as he lived and thought. It is difficult to diminish him to his real physical proportions, for his genius makes us think him as great in body as in mind. Fortunately for the truth of history, we have written testimony about him. He was five feet two inches in height, strongly built, and somewhat corpulent towards the end of life; his shoulders broad and high, his neck very short; hair of a reddish or auburn tint, afterwards grey, towards the end, white. He wore it curled at the back, not tied as was then the fashion. Eyes light-coloured. He dressed plainly and not always neatly, and in the portrait of Reynolds—here reproduced—he has an old coat of crimson velvet loosely buttoned.

Hunter is an outstanding example of the definition of genius as an infinite capacity for taking pains. His brain worked slowly but incessantly. "My mind is like a beehive," he once told Abernethy, who thought the simile admirable, for in the midst of buzz and apparent confusion there was great order, regularity, and abundant store of food which had been collected by incessant industry. Clift describes him as "standing for hours motionless as a statue, except that, with a pair of forceps in each hand, he was picking asunder the connecting fibres of some structure he was studying," and he was equally capable of prolonged absorption in thought. But the time thus spent was more than regained by his industry. After a hard day's toil in the practice of his profession, he would dine at four, rest for an hour, and then go to his workroom, where he was often left at midnight with his lamp freshly trimmed and still at work. A few hours' sleep refreshed him, and by sunrise he was dissecting again, or, in later years, writing, for it was not until 1771 that the long list of his important papers began.

The Museum which he collected is a standing monument to his industry, and remains unequalled. It is designed to illustrate the entire phenomena of life in all organisms in health as well as in disease, and it is planned on a physiological, rather than an anatomical, basis. This work of his life was for a time in danger of destruction, but the piety of Clift copied many of his manuscripts, and the generosity of the Royal College of Surgeons of England has preserved and extended his collections until they form an adequate and lasting memorial to the founder of scientific surgery.



JOHN HUNTER

From a painting by Sir Joshua Reynolds in the Royal College of Surgeons, London

U of M

OBSERVATIONS ON THE SURGERY OF THE SPLEEN.

By SIR JOHN BLAND-SUTTON, LONDON.

MY interest in the spleen began early: I remember as a boy watching a taxidermist skin a bird; during the evisceration he showed me the bird's milt, or spleen, and remarked dryly, Physiologists do not know the functions of the spleen, but dogs and men can live without it. My interest was quickened on learning that the pain, or stitch, in the inside, so annoying to those who run, is caused by the spleen swinging on its suspensory ligament.

It is believed by many, though I have failed to find a definite statement on the matter, that the Romans removed the spleen of some of the gladiators in order that they might perform feats of endurance with greater ease.

Pliny (A.D. 23–79) makes the following observation in regard to the spleen: "Sometimes it is a peculiar hindrance to runners, so that they burn it away from those runners who are incommoded by it. Animals, it is said, have had it removed and yet lived."

Although these statements do not contain anything explicit, they indicate the existence of a tradition even before the Christian era, that men and animals could live without a spleen.

Adelmann, in an admirable survey of the records of splenectomy to 1887 in reference to total extirpation of the spleen, mentions a case in which the spleen being prolapsed through a wound involving the false ribs, Viard (1581) tied the vessels and removed the spleen; the patient recovered. In 1841, Bardeleben extirpated the spleen and the thyroid gland from a dog; the animal recovered and lived in good health six years. It died from the impaction of a cystin calculus in the urethra. Thus, in 1865, when I received my first informal lesson in physiology, there was justification for the taxidermist's opinion that dogs and men could live without the spleen.

Splenectomy was not a recognized surgical operation until the latter half of the nineteenth century. In the interval between 1860 and 1890, ovariotomy began to be performed with some measure of success; this prompted surgeons to undertake the removal of enlarged spleens; but the appalling immediate results of indiscriminate splenectomy, especially when the spleen was removed for leukæmia, threatened to exclude excision of the spleen from the sphere of legitimate surgery; the admirable results which followed the judicious selection of cases since 1890 serve, however, to show that the operative risks are not greater than those of ovariotomy.

Experience teaches that the spleen can be removed without causing any serious physiological disturbance, except in the condition known as leukæmia, where its removal is quickly followed by death from shock or hæmorrhage. Nevertheless, splenectomy should not be lightly undertaken, for it is often a severe operation.

The spleen has been removed for many pathological conditions; but since

1890 surgeons have ascertained the limits of splenectomy. The following conditions justify the removal of the spleen :—

1. Injuries, such as rupture, stabs, gunshot wounds and the like, for they endanger life from hæmorrhage.

2. When enlarged and mobile the spleen is dangerous to itself, and may interfere with other viscera.

3. When the seat of malignant disease, or occupied by an echinococcus colony, or cystic from causes none can tell.

4. Splenomegaly (great spleen) associated with changes in the number, as well as in the relative proportion, of the blood corpuscles, such as exist in the conditions known as anæmia and the conglomerate group covered by the term Banti's disease.

5. Morbid conditions blood-borne, such as abscess due to the lodgment of septic emboli, tuberculosis, infarcts, and thrombosis of the splenic vein.

6. Among exceptional conditions justifying removal of the spleen may be mentioned aneurysm of the splenic artery (Winckler). In the course of removing large perirenal tumours, also in performing gastrectomy, surgeons have found it necessary to remove the spleen when it has been implicated by the growth. In such circumstances the splenectomy becomes an incident in an operation.

Noguchi removed a lipoma four feet in diameter and weighing 33 lb. from a man aged forty-two. The spleen adhered so firmly to the tumour that it was removed also. He saw the patient six years afterwards and made a microscopical examination of his blood. The man's condition was so satisfactory that Noguchi expressed the opinion that in similar circumstances the surgeons need not hesitate to remove the spleen. My experience leads me to the same conclusion.

INJURIES OF THE SPLEEN.

In the majority of instances, rupture of the spleen is a rapidly fatal accident ; death in some cases has been as speedy as when an aneurysm of the aorta has burst. The causes and consequences of injuries to the spleen vary widely. The spleen is injured by kicks from horses and from men ; falls upon pointed and angular objects, rails or ridges ; falls on the belly when drunk and even when sober, especially if the spleen is enlarged ; crushes by moving vehicles such as carts, carriages, motor-cars, or locomotives ; blows from a cricket ball or a shovel ; stabs in warfare or civil broils, and bullet wounds. When the spleen is injured by the passage of a vehicle or a severe crush, it is often complicated by fracture of the overlying ribs. Malarial spleen or ague-cake is especially liable to be ruptured, even from such slight causes as straining during vomiting, coughing, or sneezing.

It is unusual for the spleen to be badly injured without some damage to adjacent organs, except it be enlarged. Among curious modes of injury the following are worth mention :—

The spleen has been ruptured in a new-born infant dropped on the ground in a precipitate labour (Coutagne). Vincent performed cœliotomy on a woman, aged 28, in Algiers, expecting to remove a large ovarian cyst, but he found a black mass. During the manipulation his hand broke it ; there was free bleeding, and the tumour was recognized as an ague-cake. The hole in the spleen was

stuffed with gauze ; a sinus persisted for a long time, and black material escaped. It eventually closed, and nearly a year later the spleen had disappeared. The woman was in good health. Varnek operated on a young woman and succeeded in removing piecemeal something which he regarded as an adherent uterine fibroid. When the tumour was examined in the laboratory it was found to be a spleen.

Gunshot Wounds.—Bullet wounds of the spleen are not common in civil practice. The normal spleen tucked under the left costal arch does not offer a big target ; but bullet wounds of this organ do happen, and they are very fatal, for such a wound to a vascular body like the spleen is attended with alarming bleeding and the bullet nearly always injures adjacent organs : such injuries increase the jeopardy to life, and handicap the surgeon in his efforts to treat them. The following case under my own care illustrates these points : A footman, aged 17, shot himself in the chest with a revolver because the girl he loved did not requite his love. The bullet (·32) entered the chest in the fifth intercostal space half an inch below the left nipple. In the course of the operation (which entailed opening the thorax through a vertical incision involving the lower costal cartilages, and the abdomen in the left semilunar line) it was discovered that the bullet had traversed the lung, the stomach, and the spleen, and it was extracted from beneath the skin of the back. Ten ounces of blood were removed from the left pleural cavity ; many ounces were sponged from the abdominal cavity. A hole was sutured in the anterior, and one in the posterior, wall of the stomach at its cardiac pole, and the spleen, which had been traversed by the bullet, was bleeding freely. The pedicle was transfixed with silk and the spleen removed. The boy nearly died during the operation, but rallied when transfused freely with normal saline solution. Recovery was retarded by an empyema ; this required resection of a portion of a rib, and drainage. The pus contained B. coli. The boy recovered, and the girl, finding the youth so ready to sacrifice himself for unrequited love, softened her heart ; the pair are contented with each other now, although the accident went near to swelling the list of love stories with tragic endings.

The signs of severe injury to the spleen are those incidental to internal bleeding : pallor, dilated pupils, coldness of the skin, and rapid failure of the pulse. In very exceptional instances, when a large quantity of blood escapes into the belly, it may give rise to shifting dullness on percussion. The amount of blood lost varies greatly. When a rupture of the spleen involves the splenic artery or vein, rapid death from loss of blood is the rule.

Rupture of the Spleen is not always fatal. The museum of St. Bartholomew's Hospital contains a spleen from a woman who fell from a window and broke her femur ; she died ten days later. At the post-mortem examination it was seen that the spleen had been torn across, and the torn surfaces had united. There was an encapsuled collection of blood around the organ.

In order to be successful, the treatment of rupture of the spleen should be prompt. In cases where the lesion is so serious as to demand quick intervention, there is generally such damage to the organ that the only way effectively to arrest the bleeding is by removal of the spleen. As a rule, splenectomy under these conditions is a simple proceeding. Tentative measures, such as packing with gauze and drainage, have answered in some cases. We know that

occasionally patients with a ruptured spleen have recovered by what is known as "trusting to luck," but experience teaches that splenectomy is the best mode of treating such lesions. The crudest surgery is occasionally followed by success: A Rajput, aged 35, had the left side of his belly ripped by a boar, and the spleen protruded. The surgeon who saw the man at the time of the accident could neither make out the nature of the body hanging from the wound nor replace it. Nearly a month later the wound had healed, leaving the spleen outside. It contracted, and rested sessile on the abdominal wall. In this condition it resembled a Tam o' Shanter cap. Brown, who then saw the case, tied the vessels and removed the spleen. The man recovered.

MOVABLE OR WANDERING SPLEENS.

The epithet "movable," or "wandering," has been applied by surgeons to organs unduly mobile, the common examples being a mobile kidney and a wandering goitre: in none is the term so well deserved as in the case of a very movable spleen. In a well-marked instance, this organ is capable of such free excursions that it can be brought in contact with every part of the abdominal and pelvic cavities. It is difficult to conceive that the spleen, suspended to the under surface of the diaphragm by the phrenico-colic ligament (peritoneal), to the great cul-de-sac of the stomach by means of the gastro-splenic omentum, and connected to the pancreas by blood-vessels, could so elongate its attachments as to reach the floor of the pelvis. So many cases of wandering spleens have been described that it is possible to give an account of the mischief such spleens set up in the abdomen, the difficulty they cause in diagnosis, the disaster such spleens sometimes entail on their owners, and the astonishment which follows their discovery in the operating theatre or post-mortem room. It is a fact that wandering spleens are almost confined to women, and especially women who have had children. It is well to remember that there is no change which disturbs the abdominal viscera so much, and leaves such traces, as pregnancy.

There can be little doubt that the common cause of wandering spleen is increase of bulk. Such a spleen will occupy various positions in the abdomen. Occasionally it will hang in its normal place and remain for days under the left costal arch; then it will suddenly slip out and become obvious to the patient in the umbilical or iliac regions, or descend into the pelvis and imitate a pelvic tumour. All wandering spleens tend to drop into the pelvis, where they displace, and sometimes cause complete prolapse of, the uterus. When a patient with a very mobile spleen lies on her back, the spleen will fall to one side or the other; sometimes it floats on the intestines like a boat on the crest of a billow.

The effects produced by wandering spleens are remarkable, for the wandering leads to changes in the spleen and produces mechanical effects on the abdominal organs with which it comes in contact. The spleen is a contractile organ. Rhythmic movements of contraction take place at intervals of about a minute in cats and dogs. Under normal conditions the vascularity and distensibility of the spleen is very great, and these features are greatly enhanced when it hangs pendulous at the end of an elongated artery and vein. The engorgement of a spleen, when it revolves and twists its pedicle, is enormous. Pregnancy appears to be a cause of axial rotation of wandering spleens, and this accident leads to the same severe symptoms with which we are more familiar in the case

of ovarian cysts. Permanent occlusion of the splenic artery and vein by axial rotation involves atrophy of the spleen.

The effects produced by a wandering spleen on the viscera are many and various. The intimate relation of the pancreas to the spleen leads to the lengthening of this gland. Sometimes the pancreas is so stretched that its tail has reached into the pelvis when involved in a twisted pedicle. On several occasions the tail of the pancreas has been included in the pedicle when it has been necessary to perform splenectomy. I have had such an experience. Urbinati (1874) reported a case in which the stomach was involved in the twisted portion of the pedicle of a wandering spleen. The intestines are sometimes entangled in this way: small intestine, colon, sigmoid flexure, or vermiform appendix. Septic peritonitis arises from such complications, due to infection from the bowel.

In my former writings on the disturbances caused by a wandering spleen, I attributed the jaundice, which is sometimes associated with it, to mechanical obstruction of the common bile-duct due to the spleen dragging on the duodenum and stomach. A better explanation is now available (see the paragraph on acholuric jaundice and splenomegaly).

A wandering spleen may give rise to the physical signs presented by many forms of abdominal tumours and uterine fibroids. Previous to 1890 a wandering spleen had rarely been diagnosed; and when enlarged and big enough to reach the pelvis it is usually regarded as an ovarian tumour. Now that enlarged and movable spleens are included in the tables of diagnostic probabilities among abdominal and pelvic tumours, any freely movable tumour with the contour of a spleen in the abdomen or the pelvis, is suspected to be a wandering spleen. Cases have been reported in which such a spleen has been mistaken for renal swellings, especially mobile kidneys and hydronephrosis.

A pelvic spleen mimics very closely the physical signs of a pedunculated subserous fibroid. For example: A woman, aged 33, noticed a lump low in her belly shortly after the birth of her youngest child. This was regarded by her medical attendant as a pedunculated subserous fibroid; it could be moved easily into the left iliac fossa and the hypogastrium. On vaginal examination the lower pole of the tumour could be felt in the recto-vaginal fossa. When the patient lay on her back and breathed deeply, the tumour appeared to be tugged out of the pelvis. As that part of it which projected into the hypogastrium was not hard like a fibroid, and a notched border could be felt, I came to the conclusion that the supposed fibroid was a pelvic spleen. I performed splenectomy, May, 1906. A few days after the operation the patient complained of pain in the legs, especially the thighs, and the temperature remained for several days between 100° and 102°. On the twelfth day a quantity of pus escaped from the rectum, and the patient rapidly recovered. She was in good health seven years later.

ENLARGEMENTS OF THE SPLEEN DUE TO INFECTIONS CONVEYED BY THE BLOOD-STREAM.

The spleen is an extremely vascular organ, and the circulation of the blood through it is slow; in many morbid conditions of the liver the spleen acts as a reservoir for the portal circulation. There is a rare phenomenon associated

with such engorgement, known as a pulsating spleen. The combination required for its production is aortic regurgitation or hypertrophy of the left ventricle without valvular disease, and acute splenic enlargement due to an infective fever.

The slowness of the blood-current through the spleen favours the deposition of micro-organisms which the circulating blood may contain, as well as emboli and minute parasites. Temporary enlargement of the spleen is frequently detected in acute infective diseases such as typhoid, typhus, and pyæmia. In some instances the infection ends in suppuration—abscess of the spleen.

1. **Abscess of the Spleen.**—A collection of pus in the spleen arises from several causes: it may be the sequel of an injury, due to infection of extravasated blood, or the lodgment of an embolus charged with streptococci; the infecting agent may be the pneumococcus, or the amœba of dysentery.

It is difficult to diagnose a splenic from a subphrenic abscess. Collections of pus coming under the clinical denomination abscess of the spleen are often localized abscesses due to suppurative peritonitis. In some of these conditions the surgeon may find it necessary to remove the spleen, and there are conditions in which the removal of this organ facilitates convalescence.

In a case of perisplenic abscess, due, I think, to perforation of the splenic flexure of the colon, in a woman aged 35, I accidentally broke the spleen in halves in the course of an operation performed for its relief. I removed the fragments of the spleen. This happened in 1897. Sixteen years later the woman was in good health.

Enlargements of the spleen due to infection are more likely to come under the observation of surgeons in the chronic forms arising from malaria, tuberculosis, and syphilis.

2. **Malarial Spleen.**—Enlargement of the spleen is a recognized feature of chronic malaria. Such enlarged spleens are known as ague-cakes; some of them attain an enormous size and become a burden to the patient. Splenectomy for the removal of such spleens has been performed on many patients, with, on the whole, indifferent success. An analysis of the conditions indicates that when a malarial spleen is mobile (or wandering) it can be removed with a fair prospect of success. When a malarial spleen is in its normal place or occupies the pelvis, if it be adherent from perisplenitis, the risks of splenectomy are enormously increased. Johnston, in a recent report (1908) on splenectomy, collected records of 113 cases in which the spleen had been removed for "malarial hypertrophy," and mentions, on the authority of Jonnesco, that the repeated performance of splenectomy for this condition is based on the mistaken idea that the spleen continues to be a habitat for the malarial parasite.

McGraw has recorded an unusual sequel to splenectomy for an ague-cake. He removed from a woman, in June, 1887, a large malarial spleen which occupied her pelvis and presented the clinical signs of an ovarian cyst. The convalescence was troublesome. In March, 1888, she had hæmoptysis, and a month later, after a fit of coughing, she spat up the connected loops of silk used for the pedicle and presented them to the surgeon. A perusal of McGraw's description of this case shows that he took care to make his silk threads

sterile; "The thread had been rendered aseptic by first boiling in a solution of bichloride of mercury (1–1000), and afterwards boiling in clear water."

Captain F. E. Wilson, from observations on malarial patients at Meshed, Persia, has drawn attention to the frequency with which splenic abscess occurs in patients with malarial cachexia. He points out that when a patient with malaria and splenic enlargement suffers from fever (even under thorough quinine treatment) after the disappearance of the parasites from the peripheral blood, and there is evidence of softening, pain, adhesion of the spleen to the parietes, and leucocytosis, these signs indicate the existence of a splenic abscess. He furnishes short notes of three cases. He believes that such abscesses are due to " necrosis of areas of hypertrophied splenic tissue followed by infection from the blood-stream." Wilson had no means at his disposal for detecting the infecting agents.

3.—**Tuberculous Spleen.**—It is true that tuberculosis of the spleen is always secondary to a primary tuberculous focus in some other organ. A perusal of the published cases in which splenectomy has been performed for this condition makes it clear that a tuberculous spleen comes as a surprise to the surgeon in the course of the operation. It certainly did in my case. The patient had a tumour diagnosed as a wandering spleen. We knew she had a quiescent tuberculous cavity in her lung, but were astonished, on exposing the spleen in the course of the operation, to find it beset with tuberculous deposits. The woman derived great benefit from the operation, and was in good health three years later. C. Marriott had an equally successful case. I have failed to find any other examples of splenectomy for tuberculous splenomegaly in England. Fischer (1909) only succeeded in collecting records of twelve cases from the literature of a continent.

4. **Syphilitic Spleen.**—The visceral lesions of syphilis do not spare the spleen, and it is sometimes greatly enlarged by gummatous deposits. The diagnosis of such a condition is not easy, and in consequence, the spleen has been excised on several occasions for this disease.

I saw a surgeon remove from a woman, aged 33, a spleen greatly enlarged and bosselated with gummatous deposits. She recovered from the operation, but her general condition did not improve. She was re-admitted to the hospital two years later, and died. At the post-mortem examination the liver was beset with gummata.*

5. **Echinococcus Disease of the Spleen.**—Many examples of echinococcus cyst and colonies in the spleen have been described. Very large colonies have been mistaken for ovarian cysts. Most of our knowledge of hydatids of the spleen is derived from observations in the post-mortem room.

Hydatids occur in the spleen in two forms. The rarer is a solitary cyst. Of this there is an excellent example in the collection of pathological spleens at St. Bartholomew's Hospital, London. It is an ovoid cyst as big as an ostrich-egg, lodged in the middle of the spleen; each pole of the cyst is covered with a patch of splenic tissue, and a thin stratum of splenic pulp covers the circumference of the cyst on the side opposite to the hilum. The cyst contains degenerated echinococcus vesicles and membrane. This spleen was obtained

* *Middlesex Hospital Reports*, 1894 and 1896.

post mortem from a woman, aged 54, who died of acute bronchitis in an asylum. There were no symptoms during life to draw attention to the spleen. No other cysts were found in the woman. An examination of the specimen shows that the spleen with its echinococcus colony could have been easily removed (*Fig.* 68).

FIG. 68.—SOLITARY ECHINOCOCCUS COLONY IN THE SPLEEN. (*Museum, St. Bartholomew's Hospital.*)

In the same collection there is a spleen with multiple hydatid cysts. There were other cysts in the patient's abdomen, especially between the liver and the diaphragm. A study of these two specimens illustrates the mode by which the spleen was invaded by these parasitic colonies. The six-hooked embryo prefers loose subserous tissue, and in the case of the spleen the parasites occupy the loose connective-tissue meshes of the gastro-splenic omentum, and gradually invade the splenic pulp from the hilum. This is well seen in the spleen which contains multiple hydatids (*Fig.* 69).

In the case of the solitary cyst, if the parts be critically examined, a thin stratum of the splenic pulp will be seen to cover the periphery of the cyst opposite the hilum, showing that as the echinococcus colony increased in size, it spread out and flattened the tissue of the spleen in the same way that tumours arising in the paradidymis flatten out the secreting tissue of the testis until it is like a strap.

FIG. 69.—MULTIPLE ECHINOCOCCUS CYSTS OF THE SPLEEN. (*Museum, St. Bartholomew's Hospital.*)

Removal of the spleen for hydatid cysts is a rare operation. The majority of the recorded cases were treated by the antique and clumsy method of incision and drainage.

SPLENOMEGALY.

This is a useful title to cover a number of splenic enlargements following a disturbance of its function excited by causes at present unknown. The discovery of the importance of the bone-marrow in blood-formation altered the physiologist's view of the function of the spleen. Red corpuscles are formed in the spleen during fœtal life, but this office is transferred to the bone-marrow soon after birth. The spleen removes from the circulation broken-down red corpuscles, and the products of their disintegration are conveyed to the portal circulation to be further elaborated. This is a matter of importance. Perturbations of the hepatic functions are noticed in association with increased size of the spleen, and such disturbances are sometimes manifested by jaundice. Until recently, jaundice occurring in association with splenomegaly was attributed to mechanical interference with the outflow of bile into the duodenum; to-day we know that it is due to causes more subtle. The careful investigations which have been made into the relations between splenic disturbances and the numerical as well as the physical conditions of the corpuscular elements of the blood, have furnished a new method of clinical classification.

It is odd that an enlarged spleen may be associated with opposite conditions of blood such as erythræmia and anæmia. In erythræmia (Vaquez's disease) the blood contains too many corpuscles, and in anæmia too few. In erythræmia, instead of 5 million red and 6 thousand white corpuscles per cubic millimetre, the numbers may run up to 10 or even 12 million red and 24 thousand white corpuscles, with a large increase in the proportion of hæmoglobin. The enlargement of the spleen is variable; in some of the reported cases, its lower pole has reached the iliac fossa.

The clinical features of erythræmia are plethora, cyanosis, and splenomegaly. It is, in all probability, a primary disease of the red marrow. The enlargement of the spleen in this disease is due to increased functional activity, and also in part to engorgement owing to an increase in the total volume of the blood.

Leukæmia is another remarkable blood disease associated with splenomegaly, changes in bone-marrow, and profound alterations in the number and physical condition of the corpuscular elements of the blood.

Under normal conditions, the proportion of white to red corpuscles is 1–500, but in leukæmia the white may be 1–5 red, or even exceed the red corpuscles in number.

These large leukæmic spleens are objects of dread to surgeons. Probably all patients who have had such spleens removed, promptly died from hæmorrhage or shock. About 1890, the importance of a microscopic examination of the blood as a method of distinguishing the leukæmic spleen began to be recognized. To-day an abdominal tumour resembling a spleen suggests a blood-count. Leukæmia is easily recognized by the microscopic features of the blood.

In erythræmia and leukæmia surgery has no place, but a surgeon should be familiar with these conditions, for if he attempts the removal of the spleen in these diseases the enterprise can only end in disaster.

Enlarged spleens associated with anæmia constitute an important group. This combination occurs in children and adolescents. The condition is characterized by slow, progressive enlargement of the spleen, associated with diminution in the number of the red and white corpuscles.

In 1895, I removed a big spleen from a little girl on account of anæmia and splenomegaly. The child, aged five years, is probably the youngest on which splenectomy has been performed. The girl has grown into an attractive, healthy woman, aged twenty-three (1913), and works as a compositor in her father's printing works. This is a good proof that the removal of the spleen in childhood does not interfere with growth and development.

There is a form of splenomegaly accompanied by anæmia (hæmolytic anæmia) and jaundice, but no bile appears in the urine (acholuric jaundice). This is a familial disease of which the leading features have been admirably summarized by F. Parkes Weber ; they are : Chronic jaundice, splenomegaly, and a variable degree of anæmia. The jaundice is slight, and is not accompanied with icteric pruritus, xanthoma, or clubbing of the fingers. The fæces are nearly always well coloured, and the urine is nearly always free from bilirubin. The blood serum is abnormally yellow and contains bile pigment. There is always some anæmia (oligocythæmia), and the red cells easily hæmolyse. The spleen is nearly always enlarged and easily palpated, but it is not tender. I have removed two spleens for this disease. One of the patients, a female, aged 22, was under the care of Dr. Essex Wynter in 1912. The splenectomy was followed by good consequences, and the jaundice disappeared ; the spleen weighed 3 lb. In 1895 I removed a huge spleen from a girl aged 17. She was jaundiced and anæmic. Ten years later she was in good health and actively engaged as a teacher. At the date when her spleen was removed, acholuric jaundice had not been separated as a clinical entity.

There is also a conglomerate group known as Banti's disease. The leading features of this group are : Splenomegaly associated with a reduction in the number of the blood corpuscles, red and white, and, in the later stages of the disease, with cirrhosis of the liver, occasional jaundice, and ascites.

It is difficult to distinguish Banti's disease accurately—especially when its later stages are complicated with gastric hæmorrhages—from a group of symptoms set up by thrombosis of the portal vein. Any disease which interferes with the portal vein causes enlargement of the spleen : for example, cirrhosis of the liver, gummata, and tumours which interfere with the portal vein.

Obliterative thrombosis of the splenic vein leads to splenomegaly and hæmatemesis. When the vomiting of blood is profuse, surgeons are apt to overlook obstruction of the splenic vein as a cause. The symptoms are sometimes so striking that a differential diagnosis may be possible. The following is an example :—

A nurse, aged 26, suffered for six years from recurring attacks of profuse hæmatemesis associated with a big spleen. The bleeding was attributed to a gastric ulcer, and the amount of blood this nurse vomited in some of the attacks was so great that the red corpuscles of her blood were reduced to 662,000 per cmm. Gradually, the corpuscular elements would increase until they reached the proportion of 3,200,000 per cmm. This always indicated that hæmatemesis was imminent, and this invariably happened in a few days. The patient knew

when to expect an attack, and eventually died after a profuse hæmatemesis in 1895. At the post-mortem examination the spleen contained two pale infarcts, and weighed thirty-three ounces; the splenic vein was large enough to admit the index finger; it contained pouches, and at its junction with the superior mesenteric vein, was blocked by an organized thrombus. There was no lesion in the stomach to account for the bleeding. This nurse was sent to me for splenectomy from Australia in 1895. In the light furnished by the post-mortem examination, splenectomy would have been a justifiable proceeding.

It is obvious that the hæmatemesis in this and similar cases is due to engorgement of the gastric and œsophageal veins, the consequence of obstruction to the splenic vein. This would be relieved by removal of the spleen.

Splenomegaly secondary to obstruction of the portal vein has been made the subject of careful study by Edens, and especially by Pick; the account of the condition by the latter pathologist, based on a case in which the obstruction was due to an intravenous hæmangiomatous growth, contains some useful references.

Clinical and pathological studies of these secondary forms of splenomegaly are of some importance to surgeons interested in the surgery of the spleen. The great improvement in the results of removal of the spleen during the last thirty years is leading to an extension of splenectomy, and it is in this group of splenic disease that surgery may do good, for medical measures are admitted to be impotent.

Kidd suggests that "splenectomy ought to be tried in all cases of cirrhosis of the liver with enlargement of the spleen."

If it be true that chronic engorgement of the spleen causes increased blood destruction and a toxæmia that eventually proves fatal, removal of the spleen is justified.

SPLENECTOMY.

The mode of performing this operation varies with the position of the spleen, and this concerns not only the best site for exposing the organ, but also the method of securing the pedicle.

The spleen is supplied with blood by the splenic artery, which is derived from the cœliac axis, and is of large size in proportion to the spleen. As this artery approaches the spleen it breaks up into seven or more branches; in addition to supplying the spleen it distributes branches to the pancreas, and between the layers of the gastro-splenic omentum numerous branches—the vasa brevia—ramify over the great cul-de-sac of the stomach, and one larger branch, the left gastro-epiploic artery, running between the layers of the great omentum, distributes branches to the greater curvature of the stomach and inosculates with the right gastro-epiploic branch of the hepatic artery. The splenic vein joins the superior mesenteric to form the portal vein.

When the spleen is of normal size and retains its proper relations with the stomach, the vessels can easily be secured by transfixing the pedicle with a double ligature as in ovariotomy, but with a spleen measuring eighteen inches or more in length and weighing four or five pounds, the pedicle cannot be safely secured in this way. A mobile spleen lodged in the pelvis is conveniently exposed by a median sub-umbilical incision, and, if it be free from adhesions, such a spleen is

easily withdrawn from the abdomen; this allows the pedicle to be transfixed with a double ligature of silk, and tied. For security, an encircling ligature may be placed around the whole pedicle. In its simplest form the pedicle consists of the branches of the splenic artery and vein, and the peritoneum forming the gastro-splenic omentum. Occasionally, the tail of the pancreas has been included in the ligature, but this is of no consequence, except that additional care must be exercised in tightening the ligatures. As soon as the spleen is detached, the tissues of the pedicle, being elastic, quickly recede from view, and slip away under the left costal arch.

Occasionally, a pelvic spleen will adhere to the uterus, intestines, or omentum; such conditions are dealt with in the same manner as adherent ovarian tumours.

When the spleen is big, and reaching perhaps from the diaphragm to the pelvis, it is best exposed by an incision in the left linea semilunaris. It is quite easy to withdraw the lower half of a big spleen through the abdominal incision, but the upper pole is held by the phrenico-colic ligament and embarrasses the surgeon. It is of the utmost importance to set free the upper pole in order to obtain the control of the spleen. For this purpose the peritoneal ligament, which retains the upper pole of the spleen to the diaphragm, is divided cautiously with scissors; this allows the spleen to be withdrawn from the abdomen. Then the various branches of the artery are secured with hæmostatic forceps and divided close to the spleen, in order to avoid injury to the stomach. After the spleen is detached, each branch of the artery is ligatured in turn. With a big spleen, sometimes ten or twelve ligatures will be required. On two occasions when removing a very large spleen, the big splenic artery has pulsated so forcibly that I have scratched a hole with forceps through the overlying lesser omentum and ligatured the trunk in continuity; but this is an unnecessary refinement. Too much care cannot be expended in securing the vessels; one of the greatest dangers of splenectomy lies in the slipping of ill-applied ligatures after the patient has been returned to bed.

The abdominal wound is sutured according to the predilection of the operator. The success of splenectomy in appropriate cases depends, as in the surgical treatment of lesions of abdominal viscera in general, on rigid asepsis and the careful application of ligatures.

Accessory Spleens.—One or more small spleens in the neighbourhood of the hilum are by no means uncommon, and it is often recommended, in performing splenectomy, that the surgeon should look out for satellite spleens and leave them *in situ* whenever such a course is possible. Experience teaches that this is unnecessary.

The chief abnormality of the spleen relates to transposition of the viscera. The spleen is loyal to the stomach; when this viscus is transposed, the spleen lies in the right hypochondrium. Sometimes the spleen is represented by a number of splenculi, and in a case of transposition of viscera described by Abernethy (1793) the spleen consisted of seven separate portions, and a branch of the splenic artery was distributed to each.

Albrecht has described in detail the most extraordinary example of multiple spleens on record. A man, aged 25, died of nephritis, and post mortem his peritoneum was found sprinkled with a multitude of minute spleens. A spleen the size of a walnut was present in the usual position, and supplied by a normal

splenic artery and vein. An immense number of small supernumerary spleens were sprinkled throughout the abdomen. They grew from the ligaments of the liver, the mesentery, the mesocolon, and the peritoneum of the recto-vesical fossa. Each little spleen was red, and consisted of pulp with microscopic features of the spleen, had its own capsule, and was covered with peritoneum.

Another rare anomaly of the spleen is mentioned by Rolleston: The spleen gave off a long process which was bound down to the posterior abdominal wall by the peritoneum and ran down to the left side of the scrotum. In thickness it was equal to the little finger. Microscopically it was composed of splenic tissue. This observation was made in the post-mortem room. Hutchinson met with a long-tailed spleen of this sort in the course of an operation for hernia on a boy. He found a band connected with the testicle, followed it into the abdomen, and traced it upwards till it joined the spleen.

A curious set of symptoms has been noticed to follow splenectomy. As a rule, patients who have had the spleen removed suffer no more inconvenience than after ovariotomy, but in some instances the patient, a few days after the operation, has become very ill; the temperature rising to 101° or 103° at night, accompanied with loss of flesh, and pain in the long bones, especially the bones of the lower limbs. Associated with these changes there has been a diminution in the number of the red, and an increase in the number of the white, corpuscles. In a few cases there has been a temporary enlargement of the lymph-glands. I have seen these signs supervene in one patient after splenectomy. In all cases in which these unpleasant sequelæ have been reported, they gradually subsided. Probably such symptoms are due to infective changes about the stump.

Vulpius reported an interesting series of experimental splenectomies on animals (1894), and mentions that in young animals, where red marrow is present in quantity, there were no symptoms following the removal of the spleen; but in old animals there was increase of temperature and loss of flesh. This is true of man: adolescents bear splenectomy better than adults.

In regard to the enlargement of lymphatic glands after splenectomy, it has been suggested that bone-marrow takes on the function of the spleen pulp, and the lymph-glands act for the Malpighian bodies. This is mere surmise.

Vulpius records an interesting observation in one of his splenectomized dogs: The abdominal lymph-glands enlarged, and a multitude of miliary bodies were found on the peritoneum and omentum; in structure they were like the Malpighian bodies of the spleen, but in the light of Albrecht's interesting observation, previously mentioned, it is doubtful whether this peculiarity can be regarded as a sequel of the removal of the spleen.

The spleen may be regarded as an enormous lymph-gland, and its ablation exercises no graver influence on the body than the excision of a crowd of enlarged lymph-nodes from the neck, axilla, or groin.

The Statistics of Splenectomy.—Many industrious surgical writers have collected and tabulated the records relating to removal of the spleen. Conspicuous among them are Adelmann, Vulpius (1894), Berger (1902), Bessel-Hagen (1900), Johnston (1908), and Moynihan and Upcott (1913). These analytical efforts have established certain important facts:—

1. The removal of the spleen in patients with leukæmia is the most fatal

operation in surgery. Probably no leukæmic patient has recovered from this operation: death is due in most cases to uncontrollable bleeding or to shock.

2. Splenectomy for wandering spleen is accompanied by the same risks that beset an uncomplicated ovariotomy.

3. The removal of a malarial spleen is attended with a great risk: probably 30 per cent when the spleen lies in its normal position; but if free and mobile, the risks approximate to those attending a straightforward ovariotomy.

4. The risks attending the removal of enlarged spleens in the category of splenomegaly associated with anæmia are great; but the death-rate varies with the skill and experience of the operator.

When, after careful choice of cases, surgeons made splenectomy a success, pessimists admitted the surgical brilliancy of the results, but urged the importance of time to prove the ultimate success of such enterprises. Time has admirably vindicated the activity of the surgeon in regard to the spleen. It is encouraging to realize that, when patients recover from splenectomy, there is nothing in their condition to suggest that they are spleenless.

APPENDIX.

Short notes of ten cases in which the author removed the spleen and was able to obtain the subsequent history of the patient.

Case 1.—**Wandering Spleen, Axial Rotation.**

Woman, aged 22. Mother of one child. Splenectomy, 1892. Blood-count normal at the time of the operation; it was examined at intervals during the next three years and remained normal. Patient in good health 1898. (*Clinical Society's Transactions*, xxvi, 46, and xxxiv, 32.)

Case 2.—**Wandering Spleen.**

Woman, aged 33. Mother of four children. Splenectomy, 1895. A piece of the tail of the pancreas involved in the pedicle was removed also. Patient in excellent health 1900, and instead of being a "thin woman" is quite plump. A similar report was made two years later. (*Lancet*, 1895, ii, 974; *Clinical Society's Transactions*, xxxiv, 32.)

Case 3.—**Wandering Spleen.**

Woman, aged 34. Mother of seven children. Splenectomy, 1900. Patient two months advanced in pregnancy at the time of the operation. Seven months later was delivered of a living healthy baby, and reported herself in excellent health, January, 1901. (*Clinical Society's Transactions*, xxxiv, 33.)

Case 4.—**Wandering Spleen.**

Woman, aged 33. Large spleen lodged in the pelvis and resembled a subserous fibroid, but correctly diagnosed as a pelvic spleen. Splenectomy, 1906. During convalescence, the patient had fever, restlessness, rapid pulse, and pain in the legs, especially the thighs. On the twelfth day a large quantity of pus was discharged from the anus. The symptoms disappeared, and she made a good recovery. Reports of her condition were obtained at two-yearly intervals. They were always to the effect that she was in excellent health. The last report was received in April, 1913.

Case 5—**Tuberculous Spleen.**

Woman, aged 21. Mother of one child. Splenectomy, 1897, for a wandering spleen; it contained a multitude of tuberculous deposits. She had a quiescent cavity in the lung. In good health 1900. No later report. (*Practitioner*, 1898, 828; *Clinical Society's Transactions*, xxxv, 33.)

Case 6.—**Spleen Lacerated during an Operation.**

Woman, aged 35. Spleen broken in halves during an operation for relief of an abscess in the ileo-costal space, 1897. The abscess was a sequel to an attack of pelvic cellulitis following childbirth. Patient was in good health in 1899, and a later report in 1910 was to the same effect. (*Clinical Journal*, 1897, x, 369.)

Case 7.—**Gunshot Wound of Spleen.**

A youth, aged 17, shot himself in chest with a revolver. The bullet traversed the left lung, stomach (both walls), and the spleen. Splenectomy, January, 1911. He was in good health and resumed work as a footman, November, 1911. Seen again in the winter of 1912: in good health.

Case 8.—**Splenomegaly.**

Girl, aged 5. Large spleen associated with anæmia. Splenectomy, 1895. The anæmia quickly disappeared, and she became strong and well. In 1900 she was reported to be "very well, looks healthy, is of average height, but rather thin." In 1913 reported to be a healthy, attractive, and handsome woman. Private report. (*Lancet*, 1895, ii, 974. *Clinical Society's Transactions*, xxxiv, 32.)

Case 9.—**Splenomegaly.**

Girl, aged 17 years. Very large spleen associated with anæmia and jaundice. Splenectomy, 1895. She reported herself in robust health 1900. (*Lancet*, 1895, ii, 974. *Clinical Society's Transactions*, xxxiv, 32.)

Case 10.—**Splenomegaly.**

Female, aged 22. Jaundiced from birth—acholuric jaundice, anæmia, and splenomegaly. Splenectomy, 1912. The spleen weighed three pounds. Patient rapidly improved and the jaundice disappeared. (Dr. W. Essex Wynter.)

REFERENCES.

ABERNETHY, *Phil. Trans.*, 1793, lxxxiii. 59.

ADELMANN, G., Die Wandlungen der Splenectomie seit dreissig Jahren. *Arch. f. klin. Chir.*, 1887, xxxvi, 442.

ALBRECHT, H., Ein Fall von sehr Zahlreichen über das ganze Peritoneum versprengten Nebenmilzen. *Beit. z. Path. Anat.*, 1896, xx, 513.

ALLBUTT AND ROLLESTON, System of Medicine, 2nd Ed., 1903. iv, pt. i, 444.

BERGER. Die Verletzungen der Milz und ihre Chirurgische Behandlung. *Arch. f. klin. Chir.*, 1902, lxviii, 768.

BLAND-SUTTON, J., Three Cases of Splenectomy; *Lancet*, 1905, ii, 974; also *Trans. Clin. Soc.*, London, 1893, xxvi, 46, and 1901, xxxiv, 32, and *Practitioner*, 1898, lx, 288.

BROWN, H., Splenectomy for Prolapse of the Spleen through a Perforating Wound of the abdomen. *Brit. Med. Jour.*, 1897, i. 133.

CURTIS, H., AND LAWRENCE, T. W. P., Case of Portal Thrombosis, etc.; *Proc. Roy. Soc. Med. London*, 1909; Path. Sec., ii, 159.

EDENS, Uber Milzvenenthrombose und Bantische Krankheit Mitt. aus d. Grenzg. d. Med. u. Chir., Bd. xviii, 1907, 59.

EWALD, C. A., Milzen Venenthrombose mit tödlicher Magenblutung. *Deut. med. Woch.*, 1913, xxxix, 398.

FISCHER, V., Ein Beitrag zur Kenntniss des isolierten Milztuberkulose. *Wien. med. Woch.* 1909, No. 43. 2506.

FOWLER, R. H., Cysts of the Spleen. *Ann. Surg.*, 1913, 658.

HAGEN, F. B., Ein Beitrag zur Milzchirurgie. *Verhandl. der deutschen Gesellschaft f. Chir.*, Berlin, 1900, xxix, 714.

HUTCHINSON, J., A Case of Lieno-testicular Band or Ligament. *Proc. Roy. Soc. Med.*, 1913, Surgical Section, vi, 241.

JOHNSTON, G. B., Splenectomy. Report of Six Cases, with a Statistical Summary of all the reported cases up to the year 1908. *Ann. Surgery*, 1908, xlviii, 50.

KIDD, F., Case of Banti's Disease cured by Splenectomy. *Proc. Roy. Soc.*, 1913, Surgical Section, vi, 225.

LEDDERHOSE, G., Die chirurgischen Krankheiten der Milz; *Deut. Chir.*, Lief 45b. Stuttgart, 1890.

MACDONALD, I., AND MACKAY, W. A., A Case of Acute Torsion of a Wandering Spleen. *Lancet*, 1909, ii, 917.

MCGRAW, T. G., A Case of Excision of a Dislocated Spleen and Subsequent Expectoration of the Ligature of the Pedicle. *Med. Rec., New York*, 1888, xxxiii, 709.

MARRIOTT, C., Acute Tuberculosis of the Spleen: Splenectomy. Recovery. *Trans. Path. Soc.*, Lond., 1896, xlvii, 96.

MAYO, W. J., The Surgery of the Spleen. *Surg., Gyn. and Obst.*, 1913, xvi, 233.

MOYNIHAN, SIR B., AND UPCOTT, H., Surgery of the Spleen. In Keen's Surgery, 1913, vii., 619.

NOGUCHI, Y., Ueber die Exstirpation der normalen Milz beim Menschen. *Berl. klin. Woch.*, 1912, Sept. 23, 1839.

OSLER, W., Erythræmia. (Polycythæmia with Cyanosis, Maladie de Vaquez). *Lancet*, 1908, i, 143.

PICK, L., Uber totale hämangiomatöse obliteration des Pfortaderstammes und über hepatopetale Kollateralbahnen. *Virchow's Archiv.*, 1909, Bd. 197, S. 490.

PLINY, Historia Naturalis. Lib. xi, 80.

ROLLESTON, System of Medicine, 1908, iv, Pt. i, 444.

VARNEK, L. N., *Brit. Gyn. Jour.*, 1894, x., 410.

VINCENT, E., Réflexions sur le Prognostic et le Traitement des Ruptures de la Rate. *Revue de Chir.*, 1893, xiii, 449.

VULPIUS, O., Beiträge zur Chirurgie und Physiologie der Milz. *Beit. zur klin. Chir.*, 1894, xi., 633.

WATSON-WEMYSS, H. L., A Case of Vaquez's Disease (with references). *Brit Med. Jour.*, 1913, i, 702.

WEBER, F. P., Four Cases of Congenital Acholuric (so-called hæmolytic) Jaundice in one Family. *Trans. Med. Soc. Lond.*, 1910, xxxiii, 346.

WELLS, SIR T. S., Remarks on Splenectomy. *Med. Chir. Trans.*, Lond., 1888, lxxi, 255.

WILSON, F. E., Notes on Three Cases of Splenic Abscess occurring in so-called Malarial Cachexia. *Lancet*, 1913, i, 1162.

WINCKLER, V., Ein Fall von Milzextirpation wegen Aneurysma der Arteria Lienalis. *Centralbl. f. Chir.*, 1905, xxxii, 257.

WYNTER, W. E., Case of Acholuric Jaundice. *Proc. Roy. Soc. Med.*, 1913, Clinical Section, 33 and 80.

INTRAMURAL EXTENSION IN RECTAL CANCER.

By K. W. MONSARRAT, Liverpool,
and
IDWAL J. WILLIAMS, Liverpool.

Experience in operating for carcinoma of the rectum teaches that methods have to vary considerably according to the local and general condition presented by the patient. The general condition may forbid such a formidable operation as a complete abdomino-perineal amputation; the local condition may exclude any attempt to preserve the anal sphincters. One point in the discussion of method, however, is clear, namely, that operations are to be avoided which do not offer a fair prospect of going wide of the disease.

Operative experience led to the introduction of complete amputations on two grounds: (1) The frequency of recurrence following perineal and sacral amputations and resections; and (2) The disappointing results of attempts to restore or retain sphincteric control in the normal situation. The extreme view is that no operation other than a complete amputation from below the cut pelvic colon to the anus is worth doing; but a large amount of clinical experience can be cited against this. This view appeared to receive important support from the statement of Handley that in a specimen of rectal cancer he had found cancer cells (so described because they contained mucin), or small masses of mucus representing degenerate cancer cells, at least six inches above the growth, in the plane of tissue lying between the blind ends of the Lieberkühnian crypts and the underlying muscularis mucosæ. He considered that this showed permeation in a lymphatic plexus in this plane. He held that, as a factor in dissemination, this permeation was limited in effectiveness by the habitual early degeneration of the cancer cells in this situation; but in spite of this he drew the conclusion that in view of this extent of permeation, a very extensive resection of bowel above and below the growth was a right practice.

If this were to be looked upon as a representative finding and a proper deduction therefrom, the case for routine abdomino-perineal amputation would be irresistible; not only so, but all operations short of this are to be condemned as inadequate. However, apart from other considerations, the work of Cole has shown that Handley's description of his specimen does not represent the typical mode and extent of dissemination in rectal cancer in its usual form. As a further contribution to the study of the subject, we propose to describe the findings in four cases operated on recently by one of us. The extension of the disease was studied by sections of blocks in series.

Cases I, II, and *IV* were abdomino-perineal amputations, *Case III* a perineal amputation. All sections were stained by the same method, hæmatoxylin and mucicarmine. With regard to mucicarmine, it is, as is well known, a selective stain for mucin; it is probably incorrect to look upon the presence of mucin in bowel carcinoma cells as a degeneration product, and to argue that cells

which show it are ineffective from the point of view of metastasis production (Handley). It is a normal product of active bowel epithelium, and in carcinoma simply shows that the cells have not resigned this form of cell activity. Contrary to Handley's view, it is to be expected in those carcinomata which are most active in metastasis, and when present is to be looked upon as indicating particular activity in this direction. The same is true of carcinoma elsewhere in the large bowel; the "colloid" cancer of the colon is a very fatal disease, and early "recurrence" after resection is common.

Case I.—**Carcinomatous stricture of rectal ampulla close to the anal canal.**

Female, aged 52. Amputation from mid pelvic colon to anus. The rectum is the seat of an ulcer with tortuous raised everted edges; below and behind it reaches the pectinate line; its highest extent, also posterior, is $1\frac{3}{4}$ in. from the pectinate line. With the naked eye the growth in section can be seen to have penetrated the muscular coat about its centre, and to extend upwards under the mucous membrane about $\frac{1}{2}$ in. beyond the edge of the ulcer. A few glands were dissected out of the cellular tissue behind the rectum, and others from the mesocolon associated with the superior hæmorrhoidal artery. A strip of bowel was cut from the specimen involving the whole length from the anus to the point of section of the pelvic colon, measuring 9 in. in the preserved state. The lower six inches were available for examination; owing to an error in embedding, the highest 3 in. cannot be reported on. The strip available was divided into seven levels of approximately $\frac{3}{4}$ in. in depth, and each bisected, giving fourteen blocks of tissue embedded.

1. (*a*).—Normal stricture of anal canal. No traces of new growth in the sections.

(*b*).—The same. Includes the muco-cutaneous junction. No carcinoma in sections.

2. (*a*).—Mucous membrane normal and intact. At the upper end of the block there is carcinomatous growth in the submucous plane (*Fig.* 70). The cells are of smaller body than those of the mucous membrane, and are free from mucin. There are no scattered groups of carcinoma cells; the edge of the infiltration is well defined. Distally, i.e., towards the anal edge of the block, there is a well-defined metastatic mass between the fibres of the longitudinal coat (*Fig.* 71).

(*b*).—No carcinoma in sections of this block. Mucous membrane intact.

3. (*a*).—Shows carcinoma replacing the mucous membrane, also extending where the mucous membrane is still intact in a plane deep to the muscularis mucosæ (*Fig.* 72). Growth shows the usual appearance of a malignant adenoma; the cells are free from mucin. There are present also small tubular masses of cancer cells between the fibres of the longitudinal coat (*Fig.* 73). No growth in adventitia.

(*b*).—In this block, except for a few fragments of mucous membrane, the surface consists of growth. Here the growth extends deeply into the muscular coat, and is seen between the bundles of fibres of the circular coat and of the longitudinal coat.

4. (*a*).—A fragment of mucous membrane at one end of the sections; for the rest, the mucous membrane replaced by growth. A very scanty amount of growth seen between the bases of mucous membrane glands and the muscularis mucosæ at the edge of the ulcer in the form of small tubules; no isolated cancer cells in this plane (*Fig.* 74). Deep to muscularis mucosæ is massive growth of well-marked tubules, infiltrating the muscular wall. There are also cancer-cell groups in association with the vessels of the adventitia in the form of narrow columns.

(*b*).—The same massive infiltration of the muscular wall. No mucous membrane intact. Distinct growth in adventitia (*Fig.* 75).

5. (*a*).—Mucous membrane is intact. This block and 5 (*b*) are from wall just beyond ulcer. The edge of the growth where it underlies the mucous membrane is fairly well defined, and beyond the edge of the mass of growth there are no groups of cells nor scattered cells in the submucous lymphatic plane. The same infiltration of the muscular coat and of the adventitia as in 4 (*a*).

FIG. 70.—*Case I.*—Lower limit. Growth extending from left under muscularis mucosæ; small deeply-stained alveoli.

FIG. 71.—*Case I.*—Lowest growth. One inch below edge of ulcer, in longitudinal muscular coat.

FIG. 72.—*Case I.*—Extension under mucous membrane in submucous plane just beyond lower edge of ulcer.

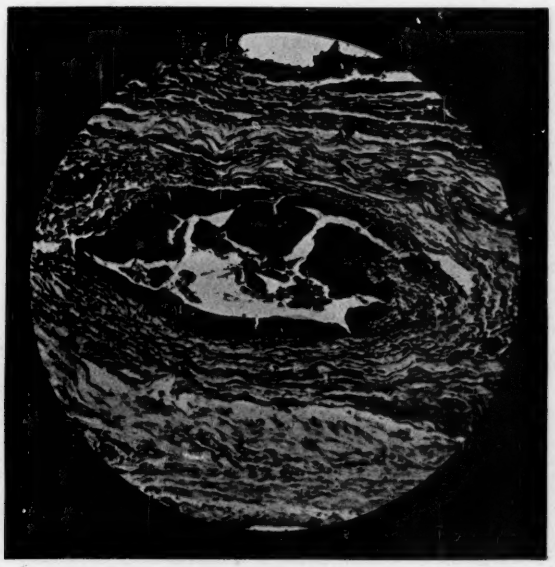


FIG. 73.—*Case I.*—Growth between fibres of longitudinal coat deep to ulcer.

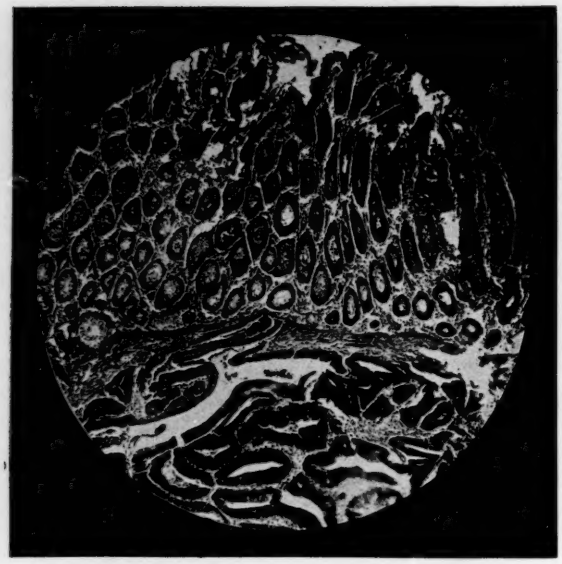


FIG. 74.—*Case I.*—Just beyond upper limit of ulcer. Shows infiltration of submucous plane and penetration of muscularis mucosæ at one spot.

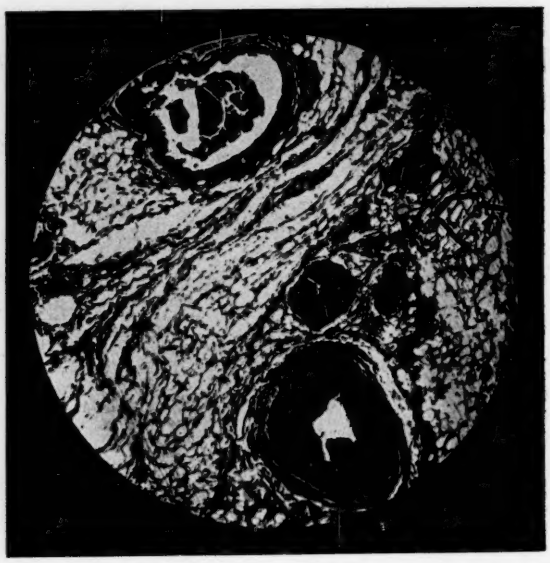


FIG. 75.—*Case I.*—Level 4 (*b*). Growth in adventitia at same level as *Fig.* 74.

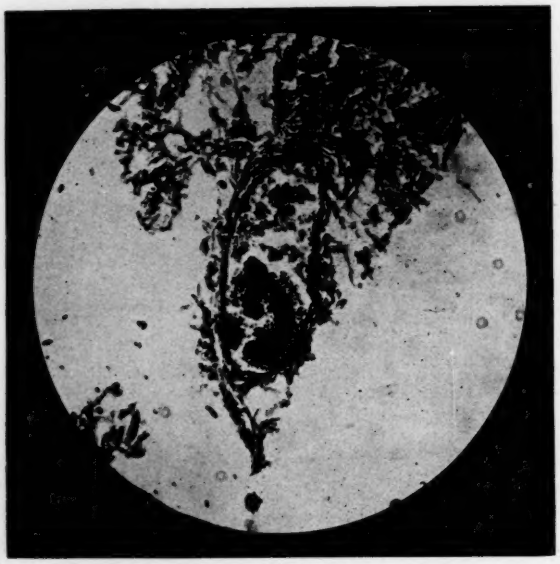


FIG. 76.—*Case I.*—Highest extension. Growth within venule in adventitia.

FIG. 77.—*Case I.*—Growth within venule in longitudinal muscular coat, near highest extension shown in *Fig.* 76.

(*b*).—Mucous membrane intact. The growth is situated on a deeper plane than in 5 (*a*). It does not reach the muscularis mucosæ anywhere, but is confined to the muscular wall. It is everywhere associated with round-cell infiltration. Mucin present in a few cells here and there. No growth-cell or cells groups in the submucous plane. Between the bundles of the longitudinal coat, growth is seen within venules, and the same in adventitia (*Figs.* 76 and 77); it is also seen well between the bundles of circular fibres in association with vessels (*Fig.* 78).

6. (*a*).—No cancer cells or cell groups in the sections for this level in any plane of the sections.

(*b*).—Sections show no carcinoma in any plane.

7. (*a*).—One or two examples of cell groups taking the mucicarmine stain are seen in close association with the bases of the glands. On examination, it is clear that these really belong to the glands, and have the appearance of isolation owing to obliquity in cutting. No metastatic cancer cells present.

(*b*).—No metastatic cells or cell groups present.

Glands from the hollow of the sacrum.—Growth is present in these glands. Mucin is present in the pseudo-acini between the cell masses, no mucin in the cells themselves, with the exception of six or eight cells per section. In a gland unaffected, cancer-cell growth seen associated with the vessels at the hilus.

FIG. 78.—*Case* 1.—Highest extension of growth between fibres of circular coat in association with vessels. Slightly below level of growth in *Figs.* 76 and 77.

Glands dissected from mesocolon.—Free from growth.

Case II.—**Within an inch of the anal canal is the edge of an ulcer which encircles the lower part of the ampulla.**

Female, aged 52. Abdomino-perineal amputation. In this case, sections were cut of the growth itself, of glands in the neighbourhood of the growth, and of high glands. A strip was also cut from the bowel, commencing half an inch above visible infiltration of the rectal wall, and extending to the point of section of the pelvic colon above. This strip was cut into seven pieces, and all sections were stained with hæmatoxylin and mucicarmine.

The Ulcer.—The growth is fibrous; it is composed of narrow tubular branches in dense fibrous tissue. The sections show growth on the surface covered by granulation tissue, and growth also extending under the mucous membrane at the upper end, making its way between the muscularis mucosæ and muscular coat. Small groups of cancer cells are seen just deep to the muscularis mucosæ, but the furthest of them is not more than $\frac{1}{4}$ in. from the edge of the ulcer. Deep to the main mass of growth, cancer-cell groups are seen: (*a*) Between the bundles of the circular muscular fibres; (*b*) Between the bundles of the longitudinal muscular coat; and (*c*) In the adventitia.

Glands.—No cancer deposit was found in any of the glands dissected from the specimen.

Bowel above Growth.—The series of seven blocks of bowel wall above the growth were examined. No cancer cells or cell groups were found in any.

FIG. 79.—*Case IV.*—Extension under normal mucous membrane below ulcer. Few cell masses superficial to muscularis mucosæ.

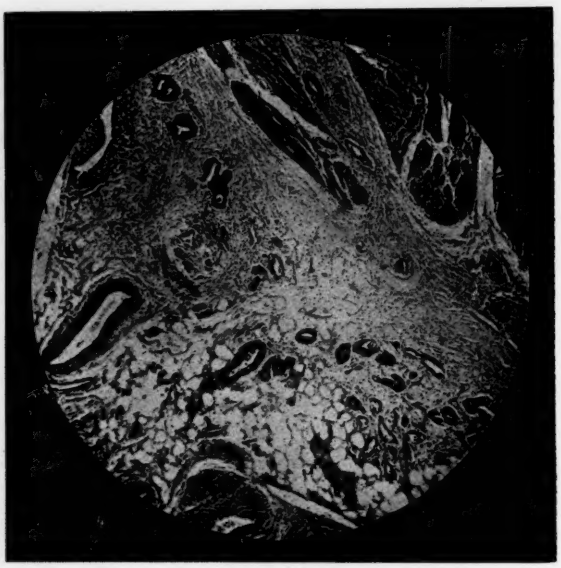


FIG. 80.—*Case IV.*—Level 6. Same level as *Fig.* 79. Growth extends to adventitia beyond lower edge of ulcer.

FIG. 81.—*Case IV.*—Level 8. Shows mucous membrane gone, and growth covered with granulation tissue.

FIG. 82.—*Case IV.*—Highest extension. Growth in adventitia, 10th level.

Case III.—**On rectal examination, a mass felt which reached the anal canal in front, and formed a ring around the lower end of the rectum.**

Male, aged 38. Perineal amputation with colostomy. Specimen shows an ulcer situated in the rectal ampulla on the anterior wall and encroaching on the lateral walls, but there is a strip of unattacked mucous membrane posteriorly 2·5 cm. in width. A strip was cut which included the edge of the ulcer below and extended to the point of section of the colon above, five inches in length. This was divided into six levels, and each of these bisected, giving twelve blocks. All the glands which were found in the specimen were embedded.

1. (*a*).—The surface consists of growth except for a fragment of mucous membrane unshed. Massive growth in the submucous plane, but edge of this is well defined and extends only a few lines beyond the ulcer edge; no isolated cancer-cell groups in this plane beyond the main mass. In the muscular coat between the longitudinal and the circular coats, and between the bundles of the circular coat, there are groups of cancer cells associated with the vessels. Practically no mucin in the cells in any situation. There is growth also in the adventitia.

(*b*).—The sections just touch the infiltration in the submucous plane; no cancer cells or cell groups in this plane beyond the main infiltration. Growth masses in adventitia, none in muscular coat.

2. (*a*).—All growth is deep to the muscular coat. Masses of growth in the adventitia, much fibrous tissue around them.

(*b*).—Growth in adventitia still more massive. As in 2 (*a*), no cancer cells or cell groups superficial to this plane.

3. (*a*).—No growth in this series. Masses of round-cell infiltration and hæmorrhage in adventitia, but no carcinoma.

(*b*).—Cancer-cell groups in the adventitia. They are confined to this coat.

4. (*a*).—No cancer cells or cell groups in these sections.

(*b*).—Small lymphatic gland in adventitia unaffected. Small but distinct tubular mass of cancer cells in the adventitia close to this gland.

5. (*a*), 5 (*b*), 6 (*a*), 6 (*b*).—Normal bowel wall. No cancer cells or cell groups in any plane.

Glands.—No cancer deposit in any of the glands dissected from the specimen.

Case IV.—**A malignant stricture three inches from the muco-cutaneous junction.**

Male, aged 50. Abdomino-perineal amputation. Feb. 21, 1913. The specimen after preservation measured 10 in. from the anus to the point of section of the pelvic colon. A broad strip of the whole length of the specimen was cut off, divided into sixteen pieces, and embedded. The growth was ulcerated. Glands to the number of nine were dissected out from the connective tissue behind the rectum, and from the mesocolon.

1. Anal canal. No growth.
2. Muco-cutaneous junction. No growth.
3. Mucous membrane. No growth.
4. No cancer cells or cell groups.
5. Round-cell infiltration associated with vessels between bundles of muscular coats. No growth.
6. Mucous membrane intact, wall of bowel contains growth. At the growth end of this block there are some cancer-cell groups superficial to the muscularis mucosæ, characterized by depth of nuclear staining and very slight extent of mucin deposit (*Fig.* 79). The longitudinal extension in this plane is for a few lines only. Deep to this there is marked infiltration of the plane between the muscularis mucosæ and the muscular wall proper. This infiltration ends abruptly at the same spot in both submucous and muscular planes. There are a few cell groups in the adventitia, where growth has extended to reach it between the bundles of circular muscular fibres (*Fig.* 80).
7. Mucous membrane intact. Massive infiltration of submucous plane, and there are a few cancer-cell groups superficial to the muscularis mucosæ. The muscular wall and adventitia also invaded.

8. Mucous membrane gone, infiltration of all coats. Superficially, the growth is covered by granulation tissue (*Fig.* 81).

9. Mucous membrane intact except near the lower edge of block. The submucous plane infiltrated, but only for a few lines beyond the ulcer. Infiltration of the muscular coat and of the adventitia extends throughout the whole length of the sections. At the upper end of the sections it is confined to the deeper layers of the muscular coat and the adventitia.

10. Mucous membrane intact. There is growth in the adventitia only in this block, none in the muscular wall (*Fig.* 82).

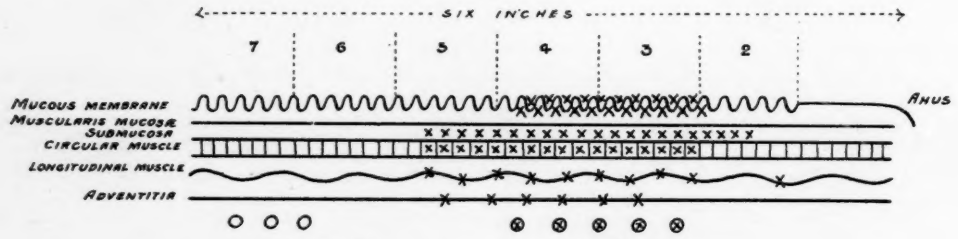
11–16. No isolated cancer cells or cell groups in any of these series.

Four glands from the neighbourhood of the growth showed invasion; the remainder, including those higher up, showed no invasion.

Measurements of the extension of infiltration in the different coats are only approximate, as no attempt was made to cut the blocks of tissue of equal axial size. The findings in these four specimens may be summarized as follows :—

Chart 1.—Extent of Growth in Various Coats in *Case I.*

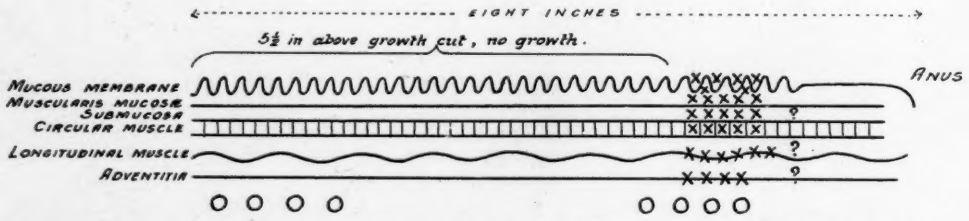
Ulcer measures $1\frac{3}{10}$ in., lower edge about 1 in. from pectinate line. Invasion of bowel wall, 3 in. Extension in various coats nearly equal, slightly more extensive in plane of longitudinal muscular coat. Extension up and down about equidistant from the edge of the ulcer. Pararectal glands invaded, higher glands not invaded. No distant permeation in any plane.



The divisions 1 to 7 refer to the blocks.
× = Growth; ⊗ = Growth in gland; O = Unaffected gland.

Chart 2.—Shows Infiltration of Coats Deep to Ulcer in *Case II.*

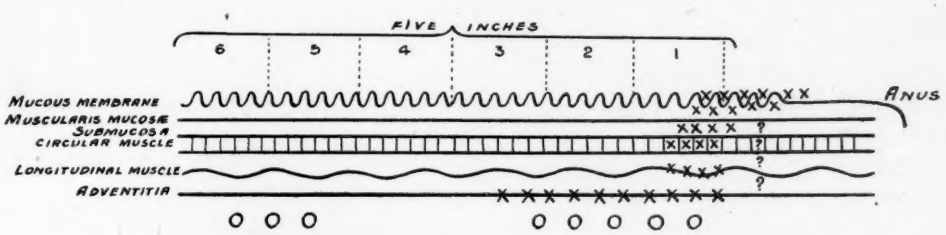
Ulcer measures about 1 in., lower edge about $\frac{3}{10}$ in. from pectinate line. All coats invaded deep to ulcer. Glands not invaded. Extent of invasion of bowel wall not investigated, but no invasion or permeation in strip of wall from $\frac{1}{2}$ in. above the ulcer to the point of section of the colon.



Absence of any growth in length of bowel from point of colon section to within $\frac{1}{2}$ in. of ulcer.
Absence of growth in glands. × = Growth; O = Unaffected gland; ? = Not examined.

Chart 3.—Shows Upward Limits of Extension of Growth in Various Coats in *Case III.*

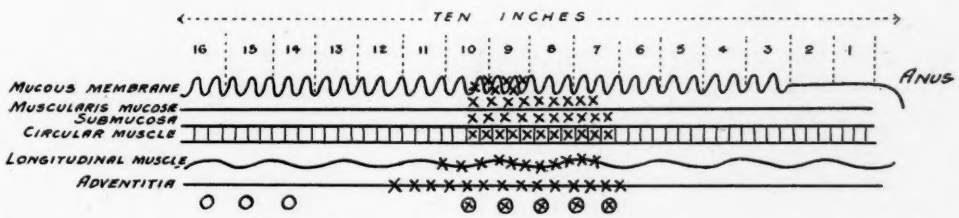
Ulcer measures about $\frac{2}{5}$ in., encroaches on anal canal. Extent of bowel-wall invasion upwards is about $2\frac{1}{4}$ in. above upper edge of ulcer. Greatest extent of invasion in plane of adventitia, invasion of other coats does not extend more than $\frac{1}{2}$ in. above edge of ulcer. No distant permeation in any plane. Glands not invaded.



Absence of growth in glands. The divisions 1 to 6 refer to the blocks.
× = Growth ; O = Unaffected gland ; ? = Not examined.

Chart 4.—Shows Upward and Downward Extension of Growth in all Coats in *Case IV.*

Ulcer measures about $\frac{3}{4}$ in., extent of invasion of bowel wall about $2\frac{1}{2}$ in. Greatest extent of invasion upwards in plane of adventitia 1 in. above upper edge of ulcer. Invasion upwards and downwards about equidistant from ulcer. Pararectal glands affected, high glands not affected. No distant permeation in any plane.



The divisions 1 to 16 refer to the blocks.
× = Growth ; ⊗ = Growth in gland ; O = Unaffected gland.

These four cases are representative of the commonest type of rectal cancer, a fibrous stenosing adeno-carcinoma, histologically tubular ; the cells have deeply-stained nuclei, and the cell bodies are almost free from mucin. They support the view that the disease, in this type, is local for a considerable period, that it penetrates the wall of the rectum locally, and extends upward and downward, chiefly in the planes of the longitudinal muscular coat and the adventitia. Further, that this longitudinal extension is not rapid and wide, but slow and restricted, the greatest distances in the four examples not exceeding one inch, half an inch, two and a quarter inches, one inch, approximately. These distances

refer to the preserved specimen: in the fresh specimen they would be slightly greater.

Further, there is no evidence that in this, the common type of the disease, growth cells and cell groups travel by way of the lymphatic plexuses to any great distance beyond the local disease; in particular that there is no permeation in a plexus associated with the mucous membrane.

The demonstration of cell masses within venules in *Case I* is of interest.

GENERAL CONCLUSIONS.

1. Carcinoma of the rectum habitually remains localized within narrow limits for a considerable period.

2. Permeation of lymphatic plexuses to a distance beyond the primary site is an exceptional process.

3. Access of the disease to the plane between the bases of the follicles and the muscularis mucosæ occurs by invasion from the submucous plane.

4. Mucin production in the cells is to be interpreted as indicating special activity, and not degeneration.

5. Infiltration is widest in the plane of the longitudinal muscular coat and the cellular tissue outside it.

6. Glandular invasion is sometimes long delayed.

7. Without wide local dissemination, the disease may make its way into blood-vessels, a process which may be responsible for distant metastasis.

A CASE OF SELLAR DECOMPRESSION.

By WILLIAM THORBURN, Manchester.

The following case is reported on account of the numerous points of interest it presents in respect to pathology, symptoms, and treatment. During life it was regarded as without doubt one of pituitary tumour, and though the post-mortem examination throws some doubt upon the exact site of origin of the growth, it may for practical purposes still be so regarded. The operation performed has some value in illustrating sundry points in connection with this branch of surgery. The extensive disease revealed by the post-mortem examination was so remarkable in connection with the slightness of the symptoms as to be in my experience unique, and its relation to the pituitary group of symptoms is of pathological interest.

J. T. J., cotton operative, a youth 19 years of age, complaining of "blindness," was transferred to my wards in the Manchester Royal Infirmary on February 26, 1913, by my colleague, Dr. R. T. Williamson. His medical history previous to the present illness was purely negative: he was a non-smoker, a total abstainer, and without any indications of disease except that he was said to have had a slight attack of pleurisy a month before admission. No evidence of disease was discoverable in the chest, and he felt, and appeared to be, in robust general health.

About three years before admission he had a very severe attack of headache, followed by urgent vomiting, after which the headache was relieved. This was followed by about five similar attacks, the last being two weeks before admission. In each of these attacks pain was undoubtedly very severe; it lasted for a few hours, and was mainly frontal. The vomiting was unassociated with nausea or with other symptoms of digestive disturbance. The abdomen was normal and general nutrition very good. About the middle of 1912 he discovered accidentally that he was blind in the left eye, and at the end of last year he consulted Dr. Charles Goulden, of Oldham, who has been kind enough to send me full notes of his case, with perimetric tracings. At that date the left optic disc presented advanced atrophy, and there was complete homonymous hemianopsia, while in the left eye the nasal field could perceive only light, or the movement of large objects such as the hand. He had noticed no change in the size of his hands, feet, or features, and had not found any necessity to enlarge his boots.

On admission, all organs were found quite healthy except as described below, but it is necessary to refer in detail to: (1) *General indications of acromegaly*; (2) *Eye symptoms*; (3) *Nervous symptoms*; (4) *Cranial changes.*

1. **Acromegaly.**—Changes, which were distinct although not very marked, and not recognized by the patient, are shown in the accompanying photographs, taken by my house surgeon, Mr. Duggan. *Figs.* 83 and 84 may be contrasted with *Fig.* 85, a photograph taken when the patient was about 17 years of age, and *Fig.* 86 shows the contrast between his own and a normal hand. The most

characteristic features of the acromegalic condition are seen to be: (*a*) The somewhat heavy features; (*b*) The "setting back" of the ear upon looking at the side of the head; and (*c*) The breadth of the hands.

FIG. 83.—Three-quarter photograph of face, showing heavy features—before operation.

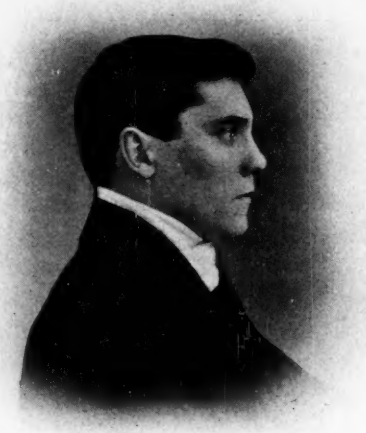


FIG 84.—Profile of face, showing slight changes of acromegaly—before operation.

2. **Ophthalmic Symptoms.**—The onset of blindness appears to have been insidious, and when first noticed nearly a year before admission, the subjective affection was probably not very different from that of 1913. At no time had it rendered him unable to work. The patient was carefully examined on January 17, 1913, by Dr. Hill Griffith, who then reported the condition to Dr. Williamson. The external appearances of the eyes were normal and the pupils equal. The *left eye* was almost completely blind, only a very bright light being recognizable, while the pupil presented no reflex to direct light; the field of vision was completely obliterated. In the *right eye* subjective vision was good, and the patient was able to go about, to read and to do his work, but unable to follow movements at a distance, and he had lost the temporal side of the visual field. There was no optic neuritis, but both discs were abnormally pale.

FIG. 85.—Photograph taken from an old group about two years before operation.

3. **Nervous Symptoms.**—Other nervous symptoms were absent. The intelligence was good. There was no loss of power or activity. Hearing, smell,

and taste were all normal There was no indication of imperfect sugar metabolism, and 5 oz. of sugar added to the daily diet produced no glycosuria.

4. **Cranial Changes.**—*Radiographic Examination.* Numerous photographs of the base of the skull were taken by Dr. A. E. Barclay, but none of them were sufficiently clear for satisfactory reproduction. All, however, showed (1) Clear definition of the ethmoidal sinuses; (2) Some want of definition of the sphenoidal sinuses; (3) A very ill-defined sella turcica, which appears to be flattened out, and has no distinct clinoid processes.

FIG. 86.—The patient's hand (the right in the illustration) compared with a normal hand taken on the same plate.

With the above data there appeared to be no doubt as to the diagnosis of a tumour of the hypophysis. Acromegaly was slight but well defined; the evidence of pressure on the optic chiasma and left optic tract was perfectly clear: there were indications of attacks of increased general intracranial tension, and enlargement of the sella turcica was established. I came to the further conclusion that the growth was possibly cystic or adenomatous, and that the anterior lobe was only partially destroyed, on the ground that the pressure symptoms were markedly more severe than were those of metabolic change.

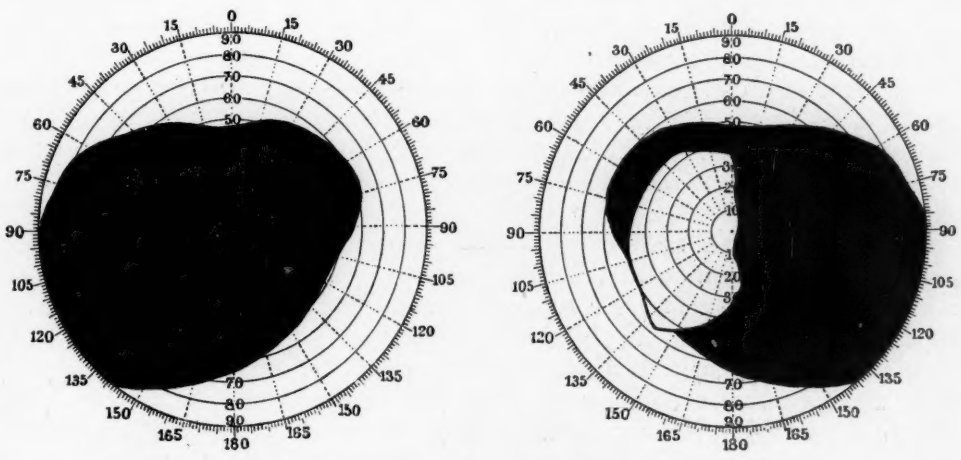


FIG. 87.—PITUITARY TUMOUR. PERIMETER CHART.

The fact that the sphenoidal sinus was hazy in outline further suggested the possibility that it might be invaded by the cyst or tumour, a suggestion which was afterwards verified.

It was now decided to operate, and, for reasons given below, to adopt the trans-nasal route of Schloffer as modified by v. Eiselsberg. For assistance in the highly essential preliminary disinfection of the naso-pharynx I must thank my colleague, Mr. Westmacott, who also helped me much both at the operation itself and in experimental observations upon the dead body. Mr. Westmacott found on examination some tonsillar folliculitis and mucopurulent discharge on the left middle turbinated bone, with pus between the septum and left Eustachian tube. Four carious teeth were removed. The tonsils were swabbed several times daily with a solution of hydrogen peroxide; the nose was syringed three times daily with a sterile solution of borax and salt, and the teeth were frequently cleaned. At the end of three weeks' time the whole naso-pharyngeal cavity and its accessory sinuses appeared to be quite healthy.

The operation was performed on February 12, 1913. During the previous twenty-four hours 60 gr. of urotropin were administered, and this was continued for two days after the operation, 30 gr. being given daily for three more days. Mr. A. Wilson anæsthetized with ether by means of the intralaryngeal tube and bellows. An incision was commenced to the right of the bridge of the nose, and carried over its root completely down the left side and through the ala into the nasal cavity. The columella was divided at its junction with the upper lip. These incisions having been carried through the soft parts, the nasal bones were divided, and the septum cut through close to the hard palate. The nose and cartilaginous septum were then turned over to the right and held back in a piece of gauze, while all superficial vessels were ligatured. With the long gouge forceps used by v. Eiselsberg, the turbinated bones were completely removed and the bony septum of the nose cut away as far down as possible until the rostrum of the sphenoid could be plainly defined. The bleeding at this stage was much less than I had expected, and was readily controlled by swabbing with epinine; but after the complete removal of the nasal contents, sponges soaked in a solution of hydrogen peroxide were plugged firmly in for a few minutes. From this time the operation was almost bloodless.

The rostrum was now quite clearly defined, and it was practicable to attack the sphenoidal sinuses in front of it and at a depth of 7 cm. from the nasal spine. This was done by the long chisels used by v. Eiselsberg, which are marked off in centimetres, it being of essential importance to note carefully the distance from the nasal spine.*

The anterior and inferior walls of the sphenoidal sinuses were thus readily removed, but the septum between the two sinuses was not identified. We now came down upon a smooth, strongly pulsating swelling which projected into, and appeared quite to fill up, the sinus, and it was at once obvious that, as had been anticipated, the upper wall of the sinus was perforated and we were in contact with the dura mater covering the tumour. The smooth contour and soft consistency of the latter suggested a cyst, but it was not considered advisable to carry matters further at this stage. It was clear that decompression was complete, and that abundant space was provided for extension of the growth or the

* Von Eiselsberg works with a radiogram taken to scale to show the precise depth in the individual skull; but I had found on the cadaver that the actual depth is so constant as hardly to call for this precaution, except perhaps in marked acromegaly.

spontaneous rupture of a cyst, while the very marked pulsation of the mass made me anxious as to the possibility of severe hæmorrhage—a result which has proved fatal in some cases.

Under these circumstances the nose was replaced and sutured in position, a drainage tube being placed in the left nostril for twenty-four hours.

The immediate post-operative condition was absolutely satisfactory. On the following day the patient was able to sit up comfortably in bed, and on the sixth day the external wound was healed and all sutures were removed. The annexed photograph (*Fig.* 88) shows the condition of the face six weeks later. In one respect the rapid recovery of health was unfortunate, as it interfered with subsequent investigation and treatment by allowing the patient to leave the hospital on the twelfth day. He then went home on account of his father's death, and I did not see him again until April. When he returned for examination the condition was as follows:—

The nose was firmly reunited, with but little disfigurement. The septum nasi was intact, but drawn over to the left so as to obstruct the left nasal passage, while that of the right side was correspondingly widened. There was a good deal of mucopurulent discharge from the naso-pharynx which had accumulated in hard crusts, and the region of the sphenoidal sinus and tumour could not be seen by the nasal speculum or by posterior rhinoscopy. The general health was perfect.

FIG. 88.—The patient six weeks subsequent to operation.

As regards symptoms for which the operation was undertaken, there was naturally no marked change. Subjective vision remained as before. The fields of vision were tested on two occasions, but no material difference was discoverable. The optic discs remained very pale. There had been no return of headache and vomiting. A radiogram contrasted with those taken before operation still presented difficulties of interpretation, but showed clearly the loss of the anterior and inferior walls of the sphenoidal sinuses.

The patient was now transferred to the care of Mr. Westmacott, in the aural department, and was treated for about six weeks for his naso-pharyngeal catarrh, which gradually improved.

On May 10th, 1913—three months after the operation—I saw him for the last time. At this date the catarrh had much improved, and with the nasal speculum the protruding tumour could be quite readily seen as a small soft mulberry-like mass, projecting from the sphenoid bone. The danger of meningeal infection was regarded as over, and a portion of the mass was removed with the snare and found to consist of gliomatous tissue with no trace of epithelial structure. On the following day he developed acute septic meningitis, from which he died in seventy-two hours.

The post-mortem examination was limited to the head. The brain having been removed, there was found, at the base of the skull, a hemispherical cavity of about an inch in diameter involving and extending the sella turcica, which could no longer be identified (*Fig.* 89). The anterior clinoid processes remained as small but well-defined projections of bone about an inch apart; the left posterior process was entirely obliterated, and that on the right side was represented by a mere spicule of bone. With the centre of the large fossa thus produced, the sphenoidal sinuses were quite continuous, and at the bottom of it an aperture large enough to admit the tip of the finger led directly into the naso-pharynx.

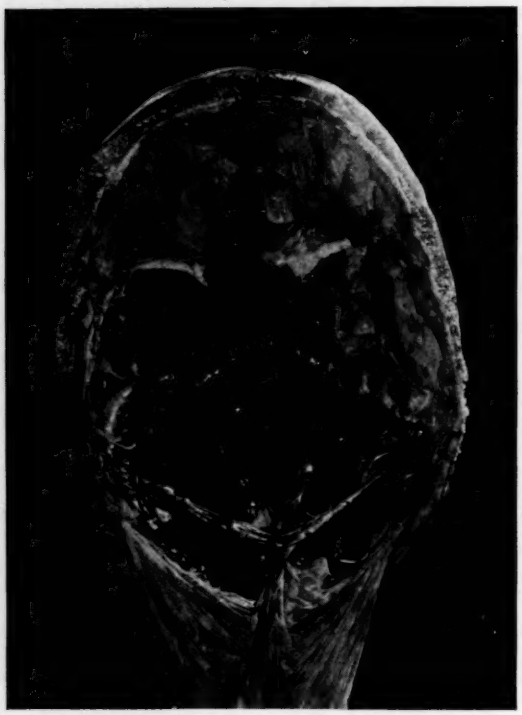


FIG. 89.—Base of skull, showing opening out of sella turcica.

The base of the brain presented extensive and quite recent suppurative meningitis, and the interpeduncular space was filled by a large soft gelatinous and highly vascular growth lying between the arachnoid and the brain, and penetrating the subdural space only at the centre of the bony fossa already described, where it passed through the aperture into the naso-pharynx. Around the margin of this opening it was adherent to the dura mater. The growth was some $2\frac{1}{2}$ inches in length, 2 inches wide, and more than an inch thick at its centre. With its greatest mass projecting upwards towards the third ventricle, but not penetrating the ependyma, it presented a central inferior lobe which was the only discoverable trace of a hypophysis. Anteriorly it extended as far as the middle of the frontal lobes, and on the left side the frontal and temporo-sphenoidal lobes were distinctly compressed. The crura and pons were not involved. The optic chiasma and left optic nerve were completely buried in the growth, but the right optic nerve was recognizable at its exit from the mass. An indistinct canal, shown in the drawing by a glass rod (*Fig.* 90) extended from the third ventricle into the projecting inferior lobe of the tumour. In structure, the mass proved to be a quite typical and highly vascular glioma with small hæmorrhages. A careful search of numerous sections made by Prof. A. E. Boycott and Dr. W. B. Anderton, failed to reveal any trace of epithelial elements, and the hypophysis could not be identified in any way, although clearly the projecting lower lobe of the growth corresponds to the position of the pars nervosa.

It was only after post-mortem examination that I had any doubts as to this case being one of hypophyseal tumour, and its true nature and extent were not even contemplated. That a growth of such size could exist in this situation without causing more marked general symptoms and without interfering with apparent health, except by producing blindness, is sufficiently remarkable, but from a purely pathological point of view the greatest interest of the case lies perhaps in the fact that a most careful search showed no trace of the epithelial structure of the hypophysis. From the complete destruction of the inner wall of the sphenoidal sinus it is possible that the craniopharyngeal canal had never been entirely obliterated, and that an easy route was thus provided for the down-growth of a tumour of the pars nervosa; but at least it appears that the anterior lobe of the hypophysis had undergone

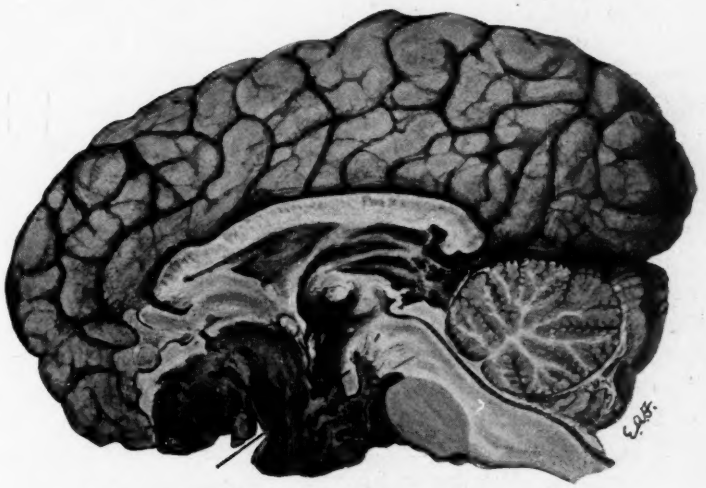


FIG. 90.—Glioma involving base of brain and extending through sella turcica into pharynx.

pressure atrophy, and that such atrophy was associated with the acromegalic changes which are usually regarded as due to hypersecretion. On the other hand, it is impossible to exclude the explanation that epithelial elements may have remained and continued their function, although not discovered histologically. We can at present only regard the case as throwing some doubt upon the view that such elements are always in excess in acromegaly.

In conclusion, I may perhaps briefly refer to a few points in connection with the more surgical aspects of this case, my apology for so doing being the comparative rarity of the operation, and the fact that it is my first personal experience.

As regards diagnosis, in this instance there appeared to be no room for doubt, and it was even recognized before operation that the sphenoidal sinus was probably perforated. The possible significance of such perforation as indicating malignancy was in my mind; but the duration of the case, the absence of any symptoms other than those above mentioned, and the general

probabilities, led me to regard it as being far more probably one of cystic adenoma, upon which basis alone it was dealt with.

The enlargements of the pituitary body are closely comparable with those of the thyroid gland. They present various pathological forms, but all varieties produce two distinct groups of symptoms, viz. (1) Pressure symptoms of increased intracranial tension, visual troubles, and alterations in size of the sella turcica ; and (2) General changes, such as acromegaly, or the adiposo-genital syndrome. For teaching purposes the term *pituitary goitre*, which commits us to no definite pathological theory, expresses very well the analogy of such conditions to those of bronchocele, and we find that pituitary goitres may, like bronchoceles, (1) Cause inconvenient or fatal symptoms as a result of pressure ; or (2) Be the cause (or possibly the result) of general constitutional conditions which we may briefly call metabolic.

The physician and the surgeon have thus to consider operation upon the thyroid gland or on the hypophysis from two different points of view. In the case of bronchocele the indications for operation to relieve pressure are clear and definite, and the results mechanical in their nature and quite certainly attained. The results as regards metabolism are far less certainly established, and even in the case of the well-known thyroid gland there is still much room for difference of opinion—for hesitation in operating upon severe cases of Graves' disease, and for difficulty in replying to the question as to how much, if any, glandular tissue ought to be removed.

" Pituitary goitres " present a similar contrast. In these also we have pressure symptoms which are, for obvious reasons, very marked and very serious, including visual troubles and the general results of increased intracranial pressure. It is for these symptoms that operation is most clearly indicated, and these symptoms can be mechanically relieved, although naturally degeneration of the optic tracts will be slowly, if at all, repaired. The case stands otherwise with regard to metabolic symptoms. We are still far from a complete knowledge of the facts. That total ablation of the hypophysis is fatal, we know, but we do not know to what extent partial removal of " pituitary goitre " corrects or aggravates symptoms, nor in what form of growth such symptoms are most commonly produced. Apart therefore from the technical difficulties of access to the hypophysis, we have, in an exaggerated form, difficulties analogous to those of the treatment of Graves' disease and of thyroid enlargements with symptoms of myxœdema.

The results of operation confirm these *a priori* considerations. In the cases which the writer has personally seen in Vienna, he was unable to satisfy himself that any improvement had occurred in the acromegalic condition, whereas pressure symptoms were undoubtedly relieved, and the same conclusion is abundantly verified by the analysis of published cases.

For these reasons I have hitherto not felt called upon to operate for acromegaly alone, and although no doubt the field of surgery is being, and will be, extended, I have regarded the relief of pressure symptoms as being at present the sole established indication for operation. Operation must also be regarded as in the main one of decompression rather than of ablation, and in cases such as ours, in which a marked protrusion of growth is found, it becomes closely analogous to an exothyropexy.

The present case appeared, however, to fulfil exactly the conditions required for success, and the next point for consideration was the route of approach.

After some hesitation I selected the transnasal route of Schoffer as modified by v. Eiselsberg. I had had the privilege of seeing several of Prof. v. Eiselsberg's cases in Vienna, and of seeing him operate upon the cadaver. I was also, by the courtesy of Prof. Elliott Smith, permitted to perform a number of operations by various routes in the dissecting-room of the Manchester University. The transcranial routes did not commend themselves to me, especially in a case in which it appeared possible that the superior wall of the sphenoidal sinuses might be eroded and the entrance to the cranial cavity thereby facilitated. I practised on the dead body both Cushing's infranasal method, and Hirsch's method of splitting the lip and columella, with resection of the septum, adopted by Hill and Graham, and recently described to the Royal Society of Medicine. These methods appeared, however, to present great difficulties to one who is not accustomed to intranasal surgery. On bodies prepared with formalin they are almost impracticable, and although no doubt they are more readily carried out on the operating-table than in the dissecting-room, the technique of the general surgeon appears to me to be hardly a sufficient preparation for the somewhat difficult intranasal operation. The only valid objections which I could find to the method of v. Eiselsberg were the cosmetic result and the interference with the sense of smell, which personal observation of the cases led me to regard as unimportant when compared with the greater ease of access and more perfect exposure of the region operated upon.

I found the operation a more easy one than I had expected, and incline to agree with Cushing that the technique is on the whole simpler than that of gasserectomy. The most serious difficulty is, however, that of dealing with the gland after it has been exposed. The surgeon cannot expect to obtain any extensive view; such a condition as was afterwards discovered in our case could not possibly be seen or appreciated; and there is but little to guide us as to how much, if any, glandular tissue should be removed. Probably any attempt at removal in our case would have led to fatal hæmorrhage, as pulsation was very marked and the tumour discovered at the post-mortem examination was highly vascular.

Having regard to these difficulties, and also to the fact that a too extensive resection will produce hypopituitarism and probably death, I think therefore, that in all doubtful cases, and certainly in all highly vascular cases, it will at present be wise to rest satisfied with decompression alone, especially as adenomata and cystic growths will probably become extruded or burst.

The greatest difficulty in all cases arises from secondary sepsis such as was fatal in the present instance. In our case it was most unfortunate that the patient had to leave hospital after twelve days and only returned as an out-patient after the pharynx had become highly septic. At the same time it is probable that had the growth been one of the anterior lobe of the hypophysis instead of a glioma practically extending into the third ventricle, the ultimate removal of the "goitre" would not have produced such serious results. It is satisfactory to realize that in any event the case must have ended fatally.

GENERAL CONCLUSIONS.

1. The above case is a remarkable instance of a large basal glioma with but few symptoms.

2. The symptoms were solely those of a hypophyseal tumour or "pituitary goitre."

3. Acromegaly was associated with apparently total atrophy of the epithelium of the hypophysis.

4. The transnasal operation was easily and successfully performed.

5. Death was due to meningitis from infection three months after operation, secondary infection being one of the most serious objections to the method adopted.

A REVIEW OF SOME OF THE MORE IMPORTANT FACTORS INVOLVED IN OPERATIONS ON THE HYPOPHYSIS CEREBRI.

By MANFRED MORITZ, Manchester.

Early accounts of diseases of the pituitary body are uncommon, the enormous amount of work and literature on this subject being practically confined to the last decade.

Littré[1], in 1707, gave a full account of a case of tumour of the pituitary body and the result of a post-mortem examination. The symptoms associated with this condition which he describes are those which we now know to be common to most cases of cerebral compression. He, however, mentions sugar in the urine, loss of memory, and increasing weakness and lassitude, all of which are pituitary symptoms on which stress is now laid.

It is interesting to note that Littré divided the pituitary body into two portions, and attempted to allocate definite functions to each. The anterior lobe, he states, "secretes air," and the posterior "cerebrospinal fluid of a 'colloid' consistency." A series of cases reported by Heslop[2] in 1848 and Scott-Orr[3] in 1852 are of little interest. The conditions noted were neoplasms, cystic changes, and abscesses. The symptomatology was almost purely that of general cerebral compression. The diagnosis was not made in any of these cases during life. The morphology of the pituitary body was placed on a sound basis in 1838 by Rathke,[4] and later by Mihalkovics[5] in 1875. Luschka[6] called this body "a nerve-gland consisting of two parts," and Virchow[7] noticed in the anterior portion colloid vesicles which he compared with those of the thyroid. This very interesting observation explains the cases of pituitary disorders reported by Eason[8] and others which reacted so favourably to thyroid extract.

In 1885–1886 Pierre Marie[9], as the result of a clinical study, associated pathological conditions of the hypophysis with a train of well-defined symptoms and skeletal changes. He gave the name "acromegaly" to this condition, and defined sharply and clearly the bony changes met with from those of Paget's disease, leontiasis ossium, and other general bone diseases. He also distinguished carefully the cachexia associated with this condition from other forms of cachexia, such as myxœdema. This is at the present time occasionally very difficult, for there are many cases in which the etiology seems to overlap, the patient having simultaneously pituitary and thyroid symptoms. Fröhlich,[10] in 1901, laid stress on the fact that pathological conditions of the hypophysis could occur without acromegaly, but with an abnormal deposit of fat, loss of sexual desire, and trophic lesions (Fröhlich's syndrome).

From this date there is an enormous amount of experimental evidence on the structure and functions of the pituitary body. It was soon decided beyond question that the anterior lobe is glandular. The posterior lobe has been variously described. W. Müller,[11] Schwalbe,[12] and Toldt,[13] looked upon it as a mass of connective-tissue cells and fibres which, during the course of development, have

destroyed all trace of the original nerve tissue. Berkeley[14] described nerve cells and glia cells in the posterior lobe. Kölliker[15] speaks very doubtfully about the matter, even after investigation by the silver chromate method. Osborne and Swale Vincent[16] could detect only few nerve cells in the infundibular portion. Peremeschko[17] showed that the posterior lobe has an epithelial investment.

The anterior lobe presents all the appearances of a gland constructed for fulfilling the function of internal secretion. Its structure is made up of a compact network of epithelial cells. In the spaces of the epithelial network run wide, thin-walled blood-vessels, so that in many cases the epithelial cells are placed directly on the delicate vessel wall. The general scheme of structure is the same as in the adrenal cortex, the islets of Langerhans, the thyroid and thymus (in its epithelial stage). Its arrangement is thus most admirably adapted for the purposes of internal secretion. Besides the colloid material, definite secreting granules have been described and demonstrated. Their origin is still under dispute. Livon[18] has worked out the dimensions and weight of the pituitary body. Haberfeld[19] has described a solid string of cells 5 mm. long, running from below upwards and backwards immediately behind the vomer. It has been called the " pharyngeal pituitary."

In 1886 Horsley[20] performed the first experimental extirpation of the pituitary body. After removal of the hypophysis a typical cachexia was produced. It was claimed, as the result of experiments involving extirpation of the pituitary body, that it was possible to localize different symptoms to different parts of the gland. Sexual disturbances were assigned to affections of the posterior lobe. The anterior lobe when affected was said to give rise to adiposity, polyuria, glycosuria, shedding of hair, atrophy of testes or ovaries, etc. Nothing conclusive was proved as to which parts of the pituitary body are essential to life, as it is impossible to define the three parts of the gland sufficiently to say definitely what amount of each had been removed ; also, different observers gave varying results and drew opposite conclusions as the outcome of experimental hypophysectomy. In cases suffering from pituitary affections, chemical researches showed interesting tissue changes, especially in regard to carbohydrate metabolism. As the result of successful extirpations of the hypophysis in animals, together with a more general recognition of the clinical signs of hypophyseal disturbances, which are now so well known, and described so fully by Cushing,[21] surgeons and rhinologists turned their attention to the perfection of a method of operation on this organ. They were considerably encouraged by the fact that in 1899 Oppenheim[22] showed that tumours of the hypophysis caused changes in the sella turcica which could be demonstrated by *x*-rays. This fact was confirmed by Fuchs,[23] Holyknecht,[24] Schüller,[25] and Ertheim.[26] It is unnecessary here to give the symptoms and various types of cases met with as the result of pituitary disorders; they have been fully and clearly described by Cushing, and a beautiful series of them has been shown lately at the Royal Society of Medicine.

A consideration of the anatomical relations of the hypophysis, and the results of the pathological conditions with which it may become affected, make it obvious that the surgeon may be called upon to perform :—

1. Sellar decompression : (*a*) For persistent hypophyseal headache ; (*b*) For the purpose of encouraging the extension of a tumour in the direction of the sphenoidal cells rather than into the cranial chamber.

2. Partial removal of a hyperplastic gland in the active stage of hyperpituitarism.

3. The removal or partial removal of a tumour for the relief of neighbouring pressure symptoms.

4. A sub-temporal decompression or sellar decompression, or both, for the palliation of general pressure symptoms when an intracranial extension has occurred.

Cushing adds :—

5. A sellar or temporal decompression to permit of the application of radiotherapy.

6. The exposure of the brain or some other organ in cases of marked hypopituitarism for the purpose of implanting a viable gland.

The latter two operations are not likely to become popular among English surgeons.

It having been decided that an operation involving exposure of the hypophysis is necessary, the question of the method of approach must be considered. The character of the hypophyseal operations which have come to be used for man, recalls to some extent the methods of experimental hypophysectomy as attempted on animals. The outcome, however, under the two conditions has been different : the experimental method in canines, from anatomical reasons, resolving itself into a preferential intracranial approach conducted under the temporal lobe rather than one below the mouth, whereas in man a median operation from below (transphenoidal) will remain unquestionably, in the vast majority of cases, the operation of choice.

Intracranial Operations.—The intracranial route, in spite of its difficulty, was the earliest operation to be performed. Caton[27] and Paul[28] (1893), Horsley, Caselli,[29] Paulesco,[30] have operated on the pituitary body by the lateral subtemporal route. Except in some rare cases of large tumours invading the brain, the route is unjustifiable and almost invariably fatal.

A frontal route has been recommended by Krause[31] (1905), Hartley,[32] and Kiliani.[33] It has been performed in 1907 by Bogoiavlensky[34] and by Frazier[35] in 1913. The operation is extremely difficult and dangerous, frequently requiring ligation of the longitudinal sinus.

The Buccal Route.—Biehl[36] recommends an operation performed through the palate. In opposing other routes, especially nasal operations, he claims his operation has the following advantages : (*a*) Broader access ; (*b*) Better view of the gland ; and (*c*) No interference with the function of the nose. He has, however, only performed his operation on the cadaver.

Transphenoidal Methods of Access.—Transphenoidal methods of access are divided into the superior nasal (of Giordano,[37] Schloffer,[38] von Eiselsberg,[39] Kocher,[40] *et alia*), and the inferior nasal (of Karavel,[41] Halstead,[42] and Hirsch[43]) types.

An operative approach with osteoplastic resection of the anterior wall of the frontal sinus and nose was proposed in 1897 by Giordano. This was improved

in 1906 by Schloffer, who, by a transphenoidal and extracranial method, was the first to report a successful operation (March, 1907). In this case the headache was cured. There was, however, no improvement in vision, but some regrowth of hair and beard. Two and a half months later the patient died suddenly with signs of intracranial tension.

In Schloffer's first operation the nose was turned down to the right, and the turbinate bones, the mid-septum, the wall of the orbit and of the maxillary sinus, together with the left nasal process of the superior maxilla, were excised. This was too radical an operation to remain in vogue. Hochenegg[44] performed a similar but less radical operation, making a small opening into the sella and scraping away the hypophysis with a spoon.

Von Eiselsberg's modification is much less mutilating. The nose is deflected to the side, the septum and turbinate bones are removed, and the ethmoid cells scraped away completely. The sphenoidal sinus is then opened and the bulging wall of the sella are exposed.

The Inferior Nasal Route.—Karavel, in 1909, demonstrated the practicability of an approach through the inferior nares. The nose is turned upwards by an external curvilinear incision through the naso-labial junction, the turbinate bones and part of the septum being removed.

This operation was practised in individual cases by Mixter,[45] Karavel and Grinker[46] in 1910. Hirsch has perfected an endonasal method founded on Hajek's route for tapping an empyema of the sphenoidal sinus. It consists in primary complete submucous resection of the septum, the remaining steps being the same as in von Eiselsberg's operation. Hirsch states that the sella can always be felt, and sometimes seen, during his operation on the cadaver. In pathological conditions, when dilated through growth, it is obvious that it will be still more evident. Hirsch performed his operation in stages with a local anæsthetic. In the hands of a skilled rhinologist, it is a beautiful and elegant operation. It has been lately performed by Hill at St. Mary's Hospital.

The chief advantages of this operation are that the sense of smell and the mucous membrane of the nose are left intact. The patient does not suffer from the intense ozæna occurring after the other nasal routes, and there is of course no deformity.

The chief points against the operation appear to be :—

1. The opening into the sella turcica is lateral.

2. The view of tumour or hypophysis is more limited than in Schloffer's operation.

Halstead (1910) was the first to recommend a sublabial instead of an infra-nasal incision, thus doing away with any facial scar.

Kocher operates through the middle line of the nose after first performing Killian's submucous resection. Cushing employs Halstead's sublabial incision, the remaining steps of the operation being practically those of Hirsch's method.

The hitherto published results of these operations bring out the following interesting and important conclusions.

In von Eiselsberg's 16 cases there were 3 men and 13 women. The ages

varied from eight to fifty-two years, the majority being over forty. There were 8 cases of the adiposo-genitalis type, 6 of hyper-pituitarism (acromegaly), and 2 of a combination of hypo- and hyper-pituitarism. There was disturbance of vision in 15 cases. Headache was present in all. Changes in the sella were demonstrable by *x*-rays in every case.

Of the 16 cases operated on, 4 died. Twelve were reported improved by the operation. The first case was reported better five years after operation, but then relapsed. Fœtor nasi occurred in 2 cases. That most important and distressing symptom, headache, was cured in all the cases, vision in all those where improvement might be expected Obesity improved in some cases, and acromegaly in only three.

Hirsch had 4 deaths out of 26 operations. One patient died from pneumonia twenty days after operation, one eight days after from meningitis, and one immediately, from hæmorrhage. In three the operation had no influence on the disease: these were very chronic cases with acromegaly. Five cases with large tumours had but temporary success. In every case headache was again relieved.

Out of 47 cases operated on by Schloffer's method by various surgeons, 17 died, mostly from meningitis.

Karavel and Cushing report 32 cases with 6 deaths.

A percentage table showing the relative mortality of these operations will run as follows:—

	Cases	Fatal	Per Cent
Hirsch, Spiers[47] Holmgren,[48]	28	3	10·7
Schloffer	47	17	37·8
Karavel, Halstead, and Cushing	32	6	18·7

Other cases reported successful: Frazier and Hill, 2.

Adding up these figures, the results arrived at are: 109 cases operated on by various routes, with 26 fatalities, a percentage mortality of 23·8.

Karavel gives the following figures as the results of his investigations: 45 cases operated on by the supranasal route resulted in 17 deaths—a mortality of 37·8 per cent: 36 cases operated on by the infranasal route, excluding Hirsch's cases, resulted in 8 deaths, or a mortality of 21 per cent.

Von Eiselsberg's results gave a post-operative mortality of 25 per cent.

The very high mortality of operations on the hypophysis is no doubt due to the fact that we are still almost in the experimental stage of the surgery of this region. With improved technique and more suitable instruments, the mortality will fall. The safest method of operating at present appears to be that of Hirsch.

It is obvious that complete extirpation of a pituitary tumour by these methods is impossible, nor is it desirable. The type of tumour most commonly met with, though histologically on the border-line of malignancy, is as a rule of a very low type of malignancy. Good results can be expected if most of the tissue is removed. Headache appears nearly always to be relieved. It is worth while operating in these cases with persistent hypophyseal headache for relief of this symptom alone. Metabolic and trophic changes are frequently improved. Sight improves in

those cases only where the optic chiasma has not been permanently injured beyond repair.

Skeletal changes and the cases of acromegaly are, apart from headache, as a rule not improved by operation.

In those cases in which the hypophysis is secondarily invaded by tumour the prognosis is bad, though Thorburn recently had an excellent immediate post-operative result in a case of this description.

Great stress is laid by the Continental authorities on :—

1. A thorough examination by *x*-rays. This gives the operator a clue as to the type of sella turcica he is going to meet with; also the anatomical variations in the sphenoidal cells, which may be obliterated or greatly enlarged.

2. Thorough removal of the turbinals and posterior ethmoidal cells. This prevents necrosis and troublesome discharge later.

3. The absence of coryza and rhinorrhœa at the time of operation. In every case developing meningitis after operation, the patients were stated to have been suffering from coryza and nasal discharge at the time, or shortly previous to the operation.

4. The value of large doses of urotropin before and after operation in guarding against meningitis.

REFERENCES.

[1] LITTRÉ, Histoire de l'Academie Royal des Sciences, 1707.
[2] HESLOP, *Dublin Quart. Jour. of Med. Sci.*, 1848, vi, 466–469.
[3] SCOTT-ORR, *Edin. Med. and Surg. Jour.*, April, 1852.
[4] RATHKE, *Müller's Archiv.*, 1838, 482.
[5] MIHALKOVICS, *Arch. f. mikr. Anat.*, 1875, xi, 389.
[6] LUSCHKA, Der Hirnanhang und die Steissdruse des Menschen, Berlin, 1860.
[7] VIRCHOW, Untersuchungen über die Entwickelung des Schadelgrundes, Berlin, 1857, s. 91–94
[8] EASON, *Proc. Roy. Soc. Med.*, 1913, May.
[9] PIERRE MARIE, *Revue de Méd.*, 1885–1886. *Brain*, 1889.
[10] FRÖHLICH, *Wien. klin. Rundschau*, 1905.
[11] MÜLLER, W., *Jenaische Zeits., f. Naturwissenschaft*, 1871, vi, 354.
[12] SCHWALBE, Lehrbuch der Neurologie, Hoffman's Lehrbuch der Anatomie, 1881, ii, 476.
[13] TOLDT, Lehrbuch der Gewebelehre, 2 Aufl., 1884, p. 290.
[14] BERKELEY, *Brain*, 1894, xvii, 515
[15] KOLLIKER, *Handbuch der Gewebelehre der Menschen*, 6 Aufl,, 1896, ii, s. 604.
[16] OSBORNE AND SWALE VINCENT, *Brit. Med. Jour.*, 1900, March 3.
[17] PEREMESCHO, *Virchow's Archiv.*, 1867, xxxviii, 329.
[18] LIVON, C. H., *Marseilles Méd.*, 1904, Nov. 15, 683–690.
[19] HABERFELD, *Zeigler's Beitr.*, 1909, June. *Frankf. Zeitschr. f. Path.*, 1910, iv. Heft i.
[20] HORSLEY, *Lancet*, 1886.
[21] CUSHING, The Pituitary Body and its Disorders, 1912.
[22] OPPENHEIM, *Arch. f. Psychiat.*, 1901, xxxiv, 303.
[23] FUCHS, Die Diagnose des Hypophysentumours. *Jahrb. f. Psych.* 1905, xxv, 230–252.
[24] HOLYKNECHT, *Arch. f. Laryng.*, 1911.
[25] SCHÜLLER, *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1904–1905, viii, 280.
[26] ERTHEIM, *Beitr. z. path. Anat. u. z. allg. Path.*, 1903, xxxiii, 158–236.
[27] CATON, J., *Brit. Med. Jour.*, 1893, p. 1421.
[28] PAUL, *Brit. Med. Jour.*, 1893, p. 1421.
[29] CASELLI, *Riv. sper. di freniat, Reggio-Emilie*, 1900, xxvi, 176, 486.
[30] PAULESCO, Paris, 1908. Vigot Frères.
[31] KRAUSE, *Deutsch klin.*, 1905, viii, 1004.
[32] HARTLEY
[33] KILIANI, *Ann. Surg.*, 1904, xl–35–43.
[34] BOGOIAVLENSKY, *Jour. de Chir.* 1912, viii, No. 4.

[35] FRAZIER, *Ann. Surg.*, 1913, Feb., part 242.
[36] BIEHL, *Centr. f. Chir.*, 1912, No. 1.
[37] GIORDANO, Compendio di Chirurgia operatorio italiana, 1897, ii, 100.
[38] SCHLOFFER, *Beitr. z. klin. Chir.*, 1906; *Wien. klin. Woch.*, 1907.
[39] VON EISELSBERG, *Wien. klin. Woch.*, 1909; *Trans. Amer. Surg. Assoc.*, 1910; *Ann. Surg.*, 1910.
[40] KOCHER, *Deut. Zeits. f. Chir.*, 1909, c. 13–37.
[41] KARAVEL (AND GRUBER), *Surg. Gyn. and Obst.*, 1910, 414–418.
[42] HALSTEAD, *Trans. Amer. Surg. Assoc.*, 1910, 73–93.
[43] HIRSCH, *Arch. f. Laryng. u. Rhinol.*, 1910 and 1912; *Jour. Amer. Med. Assoc.*, 1910; *Berl. klin. Woch.*, 1911 and 1912.
[44] HOCHENEGG, *Verhandl. d. deutsch. Gesellsch. f. Chir.*, 1908, xxxvii, 80–85; *Deut. Zeits. f. Chir.*, 1909, c. 313–326.
[45] MIXTER, *Trans. Amer. Surg. Assoc.*, 1910, xxviii, 94–109.
[46] GRINKER, *Surg. Gyn. and Obst.*, 1910, 414–418.
[47] SPIERS, *Münch. med. Woch.*, 1911, No. 47.
[48] HOLMGREN, *Münch. med. Woch.*, 1911, No. 47.

AN IMPROVED ROUTE OF APPROACH TO THE GALL-BLADDER AND BILIARY PASSAGES (Perthes's Incision).

By H. M. W. GRAY, Aberdeen.

I desire to draw the attention of British surgeons to a method of approach to the gall-bladder and biliary passages introduced by Prof. Perthes, of Tübingen.[1] I consider that this method is superior to any other. I have used it in many cases now, in eight of which stones were present in the common duct as well as in the gall-bladder. All these operations were rendered comparatively easy by using Perthes's method, which consists in making, from immediately below the ensiform cartilage, a vertical incision, about a finger's breadth to the right of the middle line. The incision curves sharply to the right immediately above the umbilicus, and is prolonged horizontally outwards to near the margin of the ribs. The anterior rectus sheath is opened in a line corresponding with the vertical incision. If necessary, the aponeurotic intersections of the rectus are separated from the inner flap of the anterior rectus sheath by cutting. Around the inner border of the rectus abdominis the index finger is inserted and pushed between the muscle and the posterior layer of its sheath at the level of the horizontal skin incision. Two rows of mattress sutures, one centimetre apart, are placed horizontally—the sutures fix the muscle to its anterior sheath; usually three are sufficient in each row (*Fig.* 91). The rectus muscle is then divided transversely between the two rows of sutures, which prevent it retracting. (This procedure is, of course, both applicable and advantageous in other laparotomies,

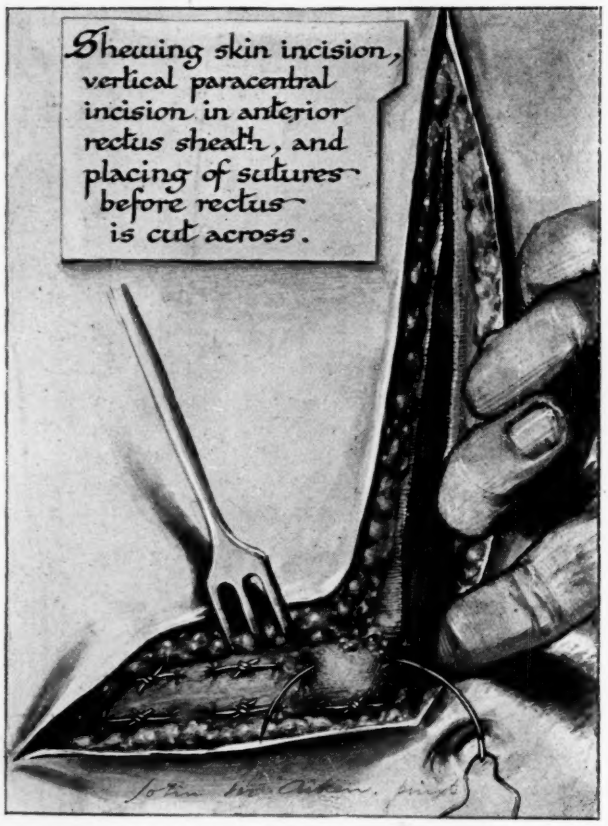

Shewing skin incision, vertical paracentral incision in anterior rectus sheath, and placing of sutures before rectus is cut across.

Fig. 91.

in which the rectus is cut transversely). The angular flap, containing rectus muscle, anterior sheath, and skin, is reflected upwards and outwards over the costal arch until the nerves entering the posterior surface of the rectus appear. Just internal to where these pierce the posterior sheath, an oblique incision, roughly parallel to the rib margins, is made, from the neighbourhood of the ensiform cartilage to near the outer angle of the wound (*Fig.* 92). If specially free access is desired, as, for example, in fat or very muscular people, the horizontal part of the skin incision can be prolonged outwards, and the different layers of muscle divided, parallel to the long axis of their fibres.

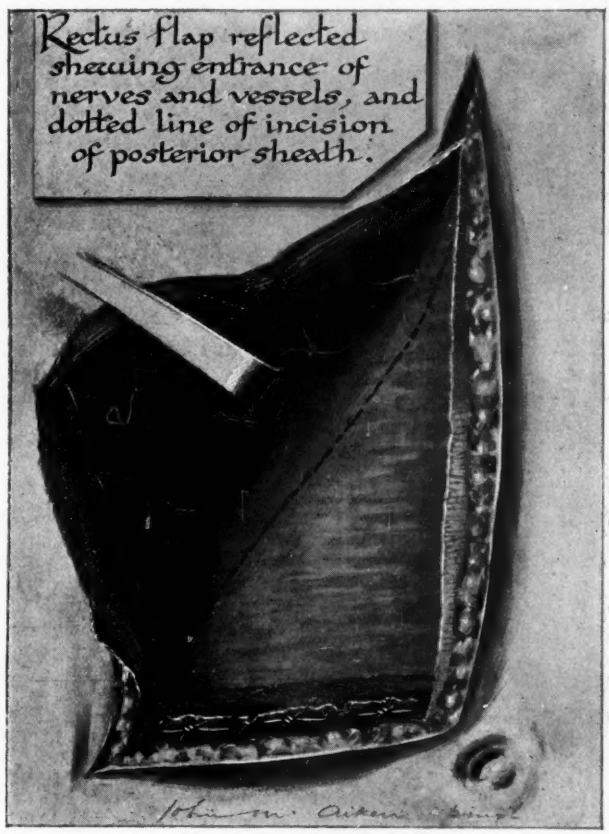


FIG. 92.

The advantages of this procedure are :—

1. The ease of approach to the biliary passages.

2. There is no danger of paralysis from division of the nerves going to the upper part of the rectus abdominis.

3. The stomach and intestines are much more easily kept away from the field of operation by packing with compresses, owing to the presence of the posterior rectus sheath, than in the angular incisions proposed by Kocher, König, and Kehr.

4. There is little or no tendency to hernia, owing to the fact that the scars in the different layers of the abdominal wall do not lie directly in line with each other. The posterior sheath is first sutured, and it is remarkable how easily this can be done. Any drain is brought out, according to convenience, at the upper or lower end of the incision. The rectus is replaced and sutured, particular care being taken to approximate accurately the edges of the anterior rectus sheath. I find it easiest to effect this by inserting a running suture through the edges of the horizontal incision in the rectus sheath, from the outer to the inner end, and leaving this loose. Through-and-through stitches, which include sheath and muscle edges and grasp the mattress sutures, are then inserted and tied from without in, the corresponding loops of the running suture being previously pulled tight (*Fig.* 93). The vertical incision in the sheath

of the rectus is approximated by continuous or interrupted sutures according to the custom of the operator. The extra time required in the earlier part of the operation is more than compensated for at the end by the excellent access afforded, the ease of suturing, and the security from hernia. When there is a tendency to oozing from the raw surfaces, I have sometimes inserted a drain of folded batiste into the dead space between the rectus and its posterior sheath.

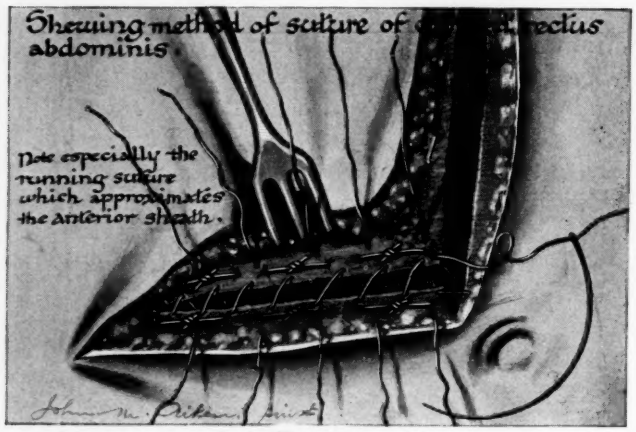


FIG. 93.

The function of the upper part of the rectus has been admirably maintained in all cases I have done. The cicatrix in the muscle makes an artificial linea transversa which does not apparently tend to stretch.

I feel that I can heartily recommend the adoption of this method.

REFERENCE.

Zentralblatt f. Chirurgie, 1912, *Nr.* 37.

THE CLINICAL PICTURE OF CONGENITAL ABSENCE OF THE FIBULA.

By EDRED M. CORNER, London.

The congenital absence of one or both bones of the leg is a deformity which owes a great deal of its interest to its rarity. Owing to our unfamiliarity with them, it is frequent for unusual deformities not to be recognized when they occur. But the absence of the fibula or tibia presents such obvious clinical features that to overlook them nowadays would be impossible. Unfortunately, absence of a fibula may be mistaken for another condition, such as intra-uterine fracture of the tibia (as recorded by Brodhurst).[1] Although superficial examination allows the condition to be misread, a fuller inspection should reveal certain features the consideration of which must lead inevitably to a true diagnosis of the condition.

The name, congenital absence of the tibia or of the fibula, is only a label given to a series of errors of development in the leg. The absence of these bones is practically always accompanied by other malformations in the leg, such as talipes valgus, syndactylism, the suppression of one or more toes, malformations of the tarsus or knee, deformity of the femur (such as that reported by Openshaw in the "Proceedings of the Royal Society of Medicine," Clinical Section, 1908, i, 8, the upper end of the femur being in several pieces). The error of development affects the fibula far more frequently than the tibia. And as the deformity called congenital absence of the fibula may be mistaken, it is well that its features should be demonstrated. Owing to its obviousness, the developmental

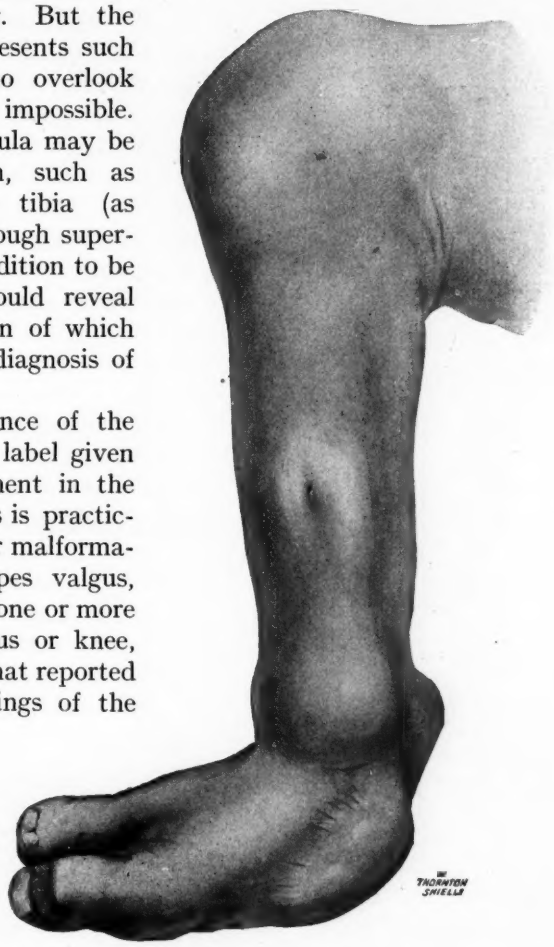


Fig. 94.—Drawing of the leg of a boy with "congenital absence of the fibula" which had been straightened, the boy having been under highly skilled care since three months old. When seven years of age the useless limb was amputated. Note the scar of the "compound fracture of the tibia."

error leading to the condition only requires to be known for its recognition. The literature of the subject is sparse but extensive. Up to 1896 it was collected into a copious monograph by Dr. Max Haudek, Assistant in Professor Hoffa's Klinik at Wurzburg.[2] Again, in 1909, in an Inaugural Dissertation at Leipzig, Dr. Strowitzki brought the subject up to date, adding a few cases which had escaped the observation of Haudek. The former has found details of 103 cases of congenital absence of the fibula. The latter has added another 57 similar cases. Scharff[3] has also done much to reduce to order the material at our disposal. To the cases already reported I have been able to add about 40 new ones. From a study of these cases and papers it is possible to make a few general observations.

FIG. 95.—Drawing of the leg of the patient described in the paper, showing the scar of the so-called compound fracture of tibia, the outward displacement of the leg and foot (valgus position), and the absence of the little-toe segment.

1. Congenital absence of the fibula is much more frequent than congenital absence of the tibia.

2. Both deformities are almost always accompanied by some other deformations in the same leg, the outer portions of the foot being lost with absence of the fibula, and the inner portion with absence of the tibia.

Other accompanying deformities are smallness of the patella, non-development of the condyles of the femur, absence of the patella.

The most frequent coincident deformities affect the toes, tarsus, and metatarsus.

3. The deformity evinces a slight tendency to occur more frequently in males than in females.

4. The deformity is found about three times more frequently affecting one side (unilateral), than it is affecting both legs (bilateral).

5. The right side is affected more often than the left. It is thought that as these deformities are found in children who have been head-presentations at birth, the more frequent affection of the right leg is due to the packing of the fœtus in utero in the left occipito-anterior (L. O. A.) position.

6. It would appear that the complete absence of the tibia or fibula is more frequent than their incomplete absence. But at least two facts must be set off against this: cases of complete absence of the bone were recognized and reported in the days before skiagraphy was introduced, and examples of incomplete absence have been reported more abundantly since then; and incomplete absence of the fibula is more easily overlooked than the complete absence.

7. In patients with congenital absence of the tibia, the limb is so useless that its amputation is practically the only treatment, should the case come to operation.

In patients with congenital absence of the fibula, all operative treatment is generally unsatisfactory because of the malformations associated with its

absence, e.g., irregularity and obliquity of the joint surfaces of the ankle. Amputation is in consequence only too often necessary. But all these cases do not come to operation. Patients can get on quite well without the fibula. For instance, Bull's[4] case (female) was seventy years old, Rosenburg's[5] patient (female) was sixty, Wagstaff's[6] (male) was forty-five, Blumenthal's[7] forty-five, and Scharff's[8] forty, clearly demonstrating that the subjects of congenital absence of the fibula may lead long and useful lives.

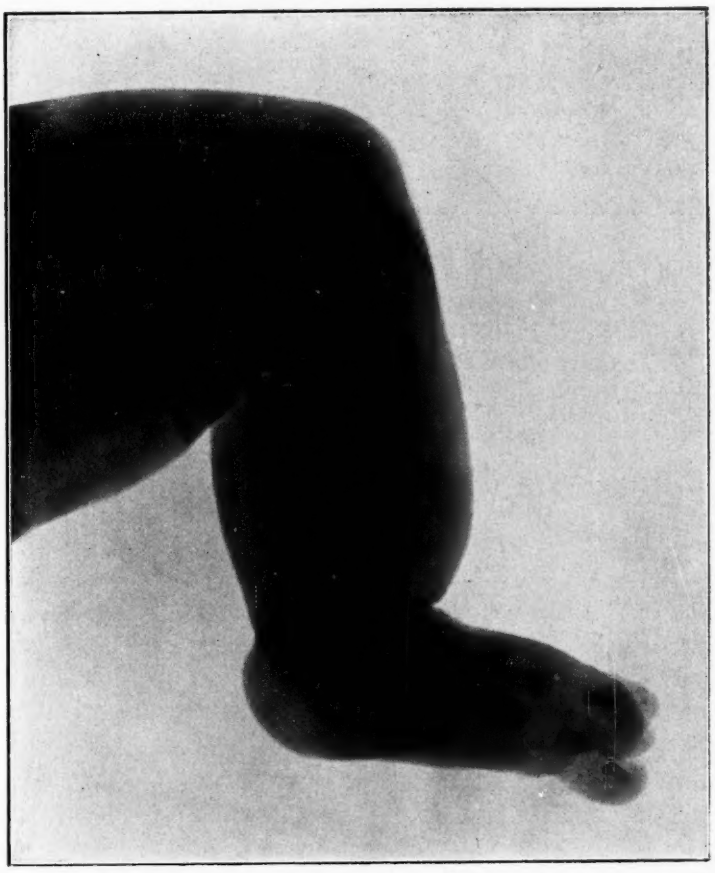


FIG. 96.—Skiagraph of the leg of a patient with "congenital absence of fibula," showing the bent tibia and the bony cartilaginous mass representing the astragalus and calcaneum. The case was regarded as an example of compound intra-uterine fracture of the tibia.

A. S., a few months old, was sent to me at the Hospital for Sick Children, Great Ormond Street, because of a deformity affecting the left leg. The appearance of this leg was most characteristic. The thigh, femur, and patella were normal; the leg was curved in its lower part, and only four toes were present. Situated over the convexity of the bent tibia was a "scar" which was slightly adherent to the bone. This "scar" avowedly suggested the previous presence of a compound fracture of the tibia, and is well shown in the drawings (*Figs.* 94, 95). A skiagraph of the leg (*Fig.* 96) showed curvature of the tibia, absence of the

fibula, the astragalus and calcaneum represented by one bony-cartilaginous mass, a deformation of the cuboid (probably), the absence of the fifth toe, with outward deflection of the leg and some talipes valgus. The case typifies the association of deformities to which is given the name of congenital absence of the fibula.

The absence of the fibula-segment of the leg is due to some developmental error, origin unknown. The bending of the tibia is due to the " packing " of the fœtus in utero. The greatest stumbling-blocks to the proper recognition of these cases is the presence of scars, often incompletely healed at birth, and somewhat adherent to the convexity of the bend of the tibia. There is no evidence of a fracture of the tibia ever having taken place, such as that derivable from sections and skiagraphs of the bent bone. But it would appear that the scar is produced by pressure of the bent bone against the amnion, forming an adhesion which is separated at birth, leaving the scar unhealed.

REFERENCES.

[1] *Medico-chirurgical Trans.* 1890.
[2] *Zeitschrift f. Orthopædische Chirurgie,* 1896, Bd. iv, 326–401.
[3] *Ibid.* 1909. Bd. xxiii, 391.
[4] HENLE AND PFEIFFER'S *Zeitschr. f. rat. Medizin,* 1861, 3 R., Bd. x.
[5] VIRCHOW'S *Archives* 1865, Bd. xxxiv.
[6] *Jour. Anat. and Phys.* 1873, Bd. vii.
[7] *Zeitschrift f. Orth. Chir.* 1905, xiv, p. 11.
[8] *Loc. cit.*

SARCOMA OF THE NOSE.

By ADAIR DIGHTON, Liverpool.

In looking over the literature for the past ten years, I have found upwards of two hundred cases of nasal sarcoma reported, and though this does not make the disease appear as rare as the text-books would have us believe, it is nevertheless not by any means common, and I think that any case is still worthy of report.

James B., aged 8, was sent to my clinic at the Birkenhead Children's Infirmary on June 20, 1913, by Dr. Robinson, who had been called in to remove a polyp from the child's nose; but seeing the condition, he refused to do so, and referred the case to me.

On Examination—A large, hard, polypus-like mass protruded from the left nostril; there was slight exophthalmos in the left eye; the left cheek was bulged out; and upon examining the mouth, a small tumour was seen at the junction of the anterior and middle thirds of the hard palate, evidently extending through it from the nose. The submaxillary, sublingual, and some of the deep cervical glands were much enlarged and densely hard.

Previous History.—On questioning the mother, a history was obtained that two years previously (1911) the child had had an operation for the removal of tonsils and adenoids, and that some twelve months after this (1912) the glands in the neck were noticed to be enlarged. No notice was taken of them, and nothing was suspected of the nose until one month before I saw the child (May, 1913). The Medical Inspector had advised the mother to have the child's tonsils and adenoids again removed on account of mouth breathing. About fourteen days after this unheeded advice, the nose was noticed to be swollen and the growth in the mouth was seen. There had never been any pain, epistaxis, discharge, dyspnœa, or dysphagia, and the only trouble was that the child snored at night. There was no family history of syphilis, tubercle, or malignant disease.

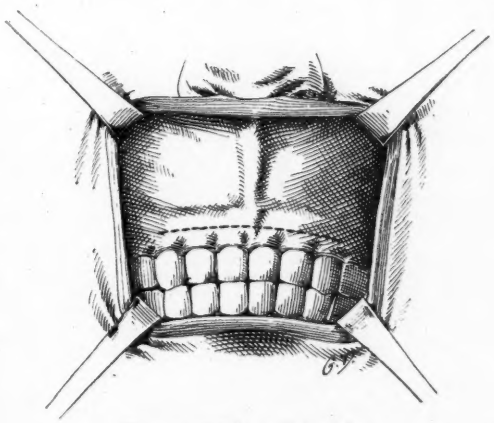


Fig. 97.—Line of incision.

The diagnosis presented little difficulty, and one of nasal sarcoma was made, with a rider that the enlargement of the glands might possibly be due to septic absorption from the base of the growth.

On June 23, the nasal cavities were packed with cocaine-adrenalin solution, and under chloroform anæsthesia I performed the operation which I have previously described[1] under the name of sub-labial-lateral rhinotomy.

With the head in the hanging, or Rose position, the upper lip was turned up against the nose, so that the mucous surface was taut and presenting outwards. A plug of gauze was then inserted at each angle of the mouth to prevent blood passing backwards, and an incision was made from molar to molar across the gum a little below the gingivo-labial fold and including everything down to the bone (*Fig.* 97). With an elevator, the soft parts were separated up until the nasal orifices came into view (*Fig.* 98), when the septum, both bony and cartilaginous, was removed by means of nasal scissors. This allowed the nose to be drawn further upwards, fully exposing the bony orifices of the nasal cavities and the antero-external wall of the maxillary antrum on each side. The left naso-antral-angle was then removed by means of bone forceps, thus opening the left antrum at its anterior angle. Then with turbinal forceps the whole internal wall, or what remained of it, was removed, so that the whole of the nose and the left antrum were thrown into one large cavity (*Fig.* 99). The tumour was then caught with the same forceps and forcibly evulsed, its base being thoroughly curetted. It could be seen that it involved the antrum and had attachments to the ethmoidal labyrinth, from which it undoubtedly arose, and the anterior wall of the sphenoidal sinus. No middle turbinate bone was present on the left side, and the inferior was of course sacrificed in the removal of the inner wall of the antrum. The opening through the palate was then enlarged and its edges were thoroughly scraped. The whole cavity was packed with gauze (24 yards of ½-in. ribbon were employed), and the patient returned to bed. No ligatures or stitches were used throughout the operation.

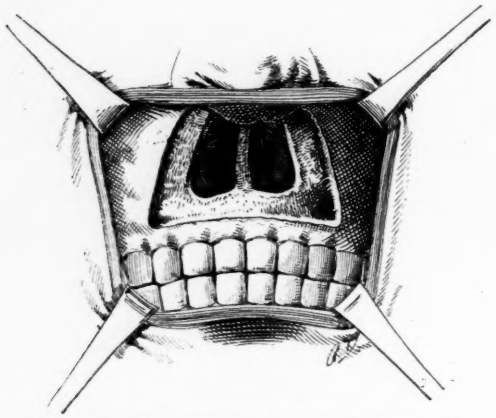


FIG. 98.—The soft parts separated up and showing the nasal orifices.

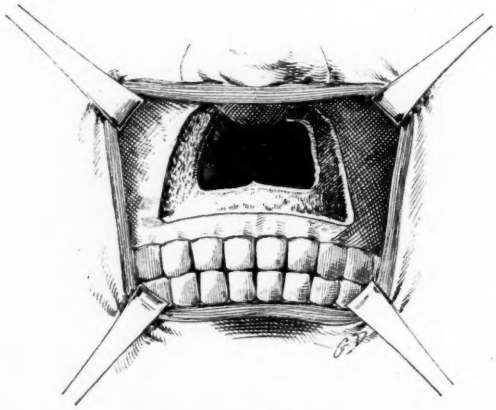


FIG. 99.—The internal wall removed, and the whole of the nose and left antrum thrown into one cavity.

Microscopical Report of Tumour.—Round-celled sarcoma.

The patient came round well from the anæsthetic, and a week later I removed the glands in the neck, including the submaxillary, sublingual, and most of the deep cervical. The submaxillary gland showed evidence of breaking down, and on microscopical examination, all were found to be infiltrated with round-celled sarcoma.

At first I thought of closing the perforation in the hard palate by means of a uranoplasty, but on account of the difficulty of anterior rhinoscopy in a child of this age, I decided to leave it open for the purpose of inspection, and got my friend Mr. Tyson to construct an obturator for it, in order that the mouth might be kept clear from the nose.

This case presents many points of interest :—

1. *The Insidious Onset.*—Though there can be no doubt that the growth was already present, the glands were the first noticeable objective symptom, and there was no epistaxis, etc. In addition to this, one month previous to admission to hospital, all that was diagnosed was mouth-breathing, and the removal of the tonsils was again ordered for its relief. In a case of such rarity it is, I think, permissible to wonder, and it would be interesting to know, what was found when the child had its adenoids removed two years back, as it seems highly probable that those adenoids (?) were in reality early sarcoma, which were lighted up by the operation and spread to the glands in an unusual way. This may sound a sweeping theory, but it should be remembered that the glands were noticed twelve months after this operation, and it is not feasible to think that they were the point of origin. The "adenoids" were probably the posterior part of the concealed sarcoma, and the lymphatics were thus infected via the tonsil, which was removed at the same time. For some reason, the right tonsil was untouched. Alexis Thomson supports this theory in his "Manual of Surgery," where he writes, "Secondary sarcoma is seldom met with in the glands except when the primary growth is in the tonsil, thyroid, or testicle."

2. *The Point of Origin.*—Farell,[2] in an interesting article on this subject, collected nineteen cases, of which five started from the middle turbinal and ethmoid, one from the base of the cranium, three from the septum and floor, and one from the inferior turbinal bone. In my case the point of origin was undoubtedly from the middle turbinal and ethmoid, and this, according to Farell, is the most common site. In his cases the maxillary antrum was involved by exenteration three times, and mine again agreed with this. In his article he writes : "In contrast to this, I have seen sarcoma of the maxillary sinus without involvement of the mucous membrane." This absolutely contradicts Price-Brown,[3] who writes : "In sarcoma of the nose the usual site of origin is in the soft tissues, and not in the bony framework which supports them." From the experience of a single case one should not perhaps draw conclusions, but I do not think there was the least doubt that the seat of origin, in my case, was the ethmoidal labyrinth and middle turbinate bone.

3. *Age of Onset.*—In Farell's cases five were in the second decade, four in the third, two in the fourth, one in the fifth, two in the sixth, and four in the seventh. Mine, appearing as it did in the sixth year, makes it appear to be unusually young.

4. *The Enlarged Glands.*—In the nineteen cases collected by Farell, the glands were enlarged in two only, and these were not definitely proved to be sarcomatous. We have been taught that one of the distinguishing features between sarcoma and carcinoma is, that in the former the glands are seldom, if ever, affected, whilst in the latter they always are. I have given my own ideas, perhaps merely theory, why the glands in my case were affected.

5. *Other Symptoms.*—Epistaxis occurred in six of Farell's cases, and was entirely absent in mine. Exophthalmos occurred in four, and swelling of the cheek and face in five of his, and both were present in mine.

Lastly.—The operative procedures that are recommended vary within wide limits, from the electro-cautery (Price-Brown) to the external operations of Ollier and Moure. The first of these necessitates twenty or thirty treatments, and is hardly applicable to a child, whilst, in regard to the other two, it seems to me that if there is a chance of the patient living, it is rather a shame to so disfigure him that he will wish he had died. Over an original operation one is naturally enthusiastic, but this operation was so much easier of performance than even I had expected, that I cannot see any objections to it. The field is bloodless, there can be no scar, there is ample room, and, granted a good anæsthetist and a smart assistant, in both of which I was exceedingly fortunate, the operation is no more difficult than an ordinary Caldwell-Luc. With the present craze on the pituitary body and its ailments, I think this operation might be used as a means of access to the hypophysis, but until I have had experience with it for this purpose I can only suggest it, whereas in naso-antral fibromas (for which I introduced it), sarcoma, and carcinoma, I think it has only to be tried to be accepted. There is no need of any preliminary laryngotomy or ligation of the carotids, etc.

REFERENCES.

[1] *Diseases of the Nasopharynx*, 1912.
[2] *Annals of Otology*, 1911, March.
[3] *Ibid.*, 1909, Dec.

ON A SERIES OF FORTY-EIGHT SUCCESSIVE CASES OF NEPHRECTOMY, WITH FOUR DEATHS.

By ANDREW FULLERTON, Belfast.

The series of cases upon which this paper is based were operated on by me during a period of six years, beginning March, 1907, and ending April, 1913. I do not give a detailed description of all, but mention in connection with them some points of practical importance to the general practitioner and the operating surgeon.

In earlier days the operation was attended with a mortality rate considerably in excess of that now attainable. This was, in part at least, due to the difficulty experienced in estimating the condition of each kidney, and if one were found extensively diseased, in coming to a correct conclusion as to the capability of its fellow to carry on the renal function. In the last edition of "The Operations of Surgery," by Jacobson and Rowlands, some interesting statistics are quoted. Mr. Jacobson mentions his own series of twenty-three cases, with four deaths, a mortality of 17 per cent. A series of ninety-five cases by Mr. H. Morris, with seventeen deaths, is quoted. The following particulars are given of the latter series :—

1. In twenty-nine nephrectomies for calculous disease there were five deaths.
2. In twenty-four nephrectomies for hydro- or pyonephrosis there were three deaths.
3. In twenty-two nephrectomies for tuberculosis there were five deaths.
4. In seventeen nephrectomies for tumour there were four deaths.
5. In three nephrectomies for fistula there were no deaths.

This gives a mortality for the whole series of nearly 18 per cent.

Tuffier's statistics published in 1899 are also quoted. These give a mortality of 38·4 per cent in 200 lumbar nephrectomies, and 44·1 per cent in 161 transperitoneal nephrectomies.

The most recent series of cases I can find is that of Gerster, of New York,[1] comprising a term of sixteen years from 1895 to 1911. He gives the following statistics. The total number of nephrectomies was 112, with a mortality of 21·33 per cent. The particulars are as follows :—

1. Pyonephrosis, sixty-one cases with nine deaths, a mortality of 14·75 per cent.
2. Tuberculosis, twenty cases with four deaths, a mortality of 20 per cent.
3. Hydronephrosis, eleven cases with three deaths, a mortality of 27·27 per cent.
4. Neoplasms, eighteen cases with eight deaths, a mortality of 44·4 per cent.
5. Echinococcus, two cases with no death.
6. Polycystic disease, one case with no death.

Coming now to my own series, it will be seen that three of my cases died as the direct result of the operation—a mortality of 6·2 per cent—or if a case which died six weeks after the operation, and which will be further referred to later, is included, the mortality was 8·3 per cent in forty-eight cases. I attribute the comparatively low mortality in this series to the methods adopted to estimate the capacity of the remaining kidney. Two of the deaths occurred in cases of tuberculous kidney. In *Case* 12, *Group A*, death occurred from sepsis. The patient had a large perinephritic abscess. The affected kidney was firmly adherent and obsolete. A fæcal fistula formed a few days after operation, probably owing to interference with the blood supply of the colon. Death took place from exhaustion six weeks after operation. In *Case* 38, *Group A*, the affected kidney was converted into an enormous sac distended with pus, and much difficulty was experienced in separating it from its surroundings. The peritoneal cavity was accidentally opened during the operation, but was immediately closed by suture. The patient, a girl, aged 17, died the following day from shock. There was some albumin in the urine from the sound side, but not more than I have found in other cases in which nephrectomy was successfully carried out. In *Case* 11, *Group B*, to which further reference will be made, I unfortunately removed the only functioning kidney the patient possessed. I have never ceased to regret that I did not, previous to the operation, estimate the capacity of the other kidney. This was the only case in which I trusted the opposite kidney, and my selection was, to say the least of it, unfortunate.

The methods in general use for estimating the functional capacity of the kidneys are numerous, but in my own practice I have tried to simplify matters as far as possible. If the urine obtained by ureteral catheter from the presumably sound kidney has a sp. gr. of 1015 or over, is free from albumin, pus, and blood, and is secreted in normal quantity, having regard to the fact that the other kidney, being diseased, is as a rule secreting a larger quantity of urine of a lower sp. gr., I have no hesitation in removing the offending organ. Although I adopt this as a broad rule, I have, as will be seen from the accompanying table, departed from it in a few instances. A trace of albumin on the good side would not deter me, other conditions being favourable, and a few pus cells would not necessarily negative operation, though I should carefully consider all the features of the case, taking the general health and age of the patient into consideration, before adopting radical measures. A low sp. gr. on the good side must be carefully investigated; if this is due to a diuresis produced by drugs, as in *Case* 24, *Group F*, no serious notice need be taken of it. The mixed urine must be examined at frequent intervals and its sp. gr. noted. As will be seen by reference to the table, the sp. gr. of the urine on the affected side is seldom more than 1005. In addition, the quantity of urine on the affected side is, as a rule, greater than on the sound side. If, therefore, the sp. gr. of the urine in the bladder is 1010 or over, the evidence is strongly in favour of the urine from the presumably healthy side being of much higher sp. gr. This lowered sp. gr. on the affected side is due, in most cases, to increased flow of blood through the organ, caused by irritants such as tubercle and calculus, and is a valuable means of diagnosis. On glancing at the table, a difference in the sp. gr. on the diseased and healthy sides will be seen to be an almost universal rule. The diuresis which takes place owing to nervousness and the ingestion of large quantities of fluid

can be estimated at its proper value by attention to the rules formulated above. In hydronephrosis and extensive destruction of the kidney, the low sp. gr. of the urine on the affected side is due to the inability of the kidney to separate the solid constituents of the urine from the blood.

It is a serious drawback that, even with the most careful handling, the ureteral catheter will occasionally draw blood, especially after prolonged stay in the ureter. If the urine drawn from the bladder does not contain blood, the presence of the latter in the ureteral specimen must, of course, be attributed to trauma. If blood be present in the bladder before ureteral catheterization, the utmost care must be taken to avoid wounding the delicate mucous membrane of the ureter, otherwise the results of the examination may be vitiated. As a general rule, I use the ordinary small-sized catheter, which is softer than the usual long ureteral one. It is seldom necessary to use the long instrument. An inch or two inside the ureteral orifice is ample for all the usual examinations.

Age.—The ages of the patients varied from three to sixty-five years. Two of the cases were children, aged three years, and three years and two months, respectively. Both were females, and in both I used the transperitoneal route. The oldest patient was a male, aged sixty-five years, with a hypernephroma.

The indications for operation were as follows :—

1. **Renal Tuberculosis** (*Group A*).—There were twenty-two of these cases, with two deaths. It will be seen from the table that fifteen of these remain well for periods varying from six months to six years after operation. Two died about a year after nephrectomy, one has developed phthisis and is doing badly, one has only recently been operated on, and one has been lost sight of. In only five known cases, therefore, has the ultimate result been unsatisfactory. These statistics are encouraging, when one remembers the usual progressively downhill course taken by cases of tuberculous kidney when treated by conservative methods. The symptoms complained of by these patients varied from the slightest discomfort to the most intense suffering.

In *Case* 29, the only complaint was the presence of a sediment in the urine. The patient looked strong and well. Operation disclosed a kidney three or four times the normal size, distended with pus. The ureter was much thickened, and in removing the diseased organ, which was densely adherent to its surroundings, the suprarenal capsule was torn, and a portion of it came away with the kidney. In addition, several branched stones were found in the dilated calices and infundibula.

In some of the cases the patient had typical renal colic.

In *Case* 6, after several attacks of renal colic, attended on one occasion with hæmaturia, the pain in the side passed off, to be followed by frequency of micturition and pain in the glans penis. This history is quite suggestive of renal calculus. Operation showed a kidney about twice the normal size, with well-marked adhesions at the upper pole. On section, the kidney was found to be hollowed out at its upper pole into several cavities containing pus. About the centre of the organ were several caseating masses. The lower pole was comparatively free except for a few grey tubercles. The ureter was thickened.

In other cases, the patient's complaint was of frequency of micturition and penile or meatal pain, sometimes of the most unbearable character. It will be seen from the table that this type of case formed a large proportion of the whole.

The kidneys removed for tubercle presented all degrees of infection. In *Case* 48 (*Fig.* 100) the kidney on exploration appeared to be normal. Inasmuch as pus containing tubercle bacilli had previously been found by the ureteral catheter in the specimen from that side, the kidney was removed without cutting into it. It was not increased in size. On removing the capsule, a number of grey tubercles were found scattered over the cortex, and on section, caseation had taken place in the upper pole, forming a small abscess which had opened into one of the upper calices. Tubercles were present at the apices of the pyramids. The main part of the kidney was quite normal. In the early cases the ureter was, as yet, uninvolved. In most of the later cases the pyramids were encroached upon from the apices outwards, leaving ragged spaces lined by caseous material. Breaking-down caseous nodules in the parenchyma of the organ were of frequent occurrence. The opening of one or several of these into the calices gave rise to the first prominent symptoms of the complaint, i.e., renal pain or colic, or bladder irritability (*Fig.* 101).

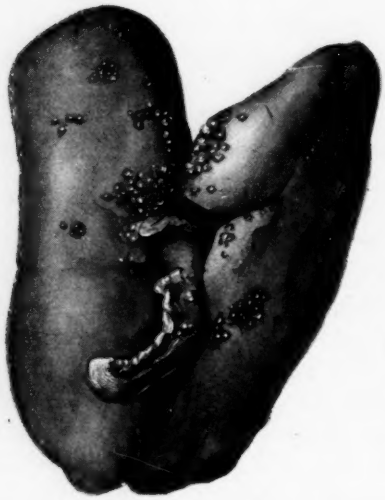


FIG. 100 — Early stage of tuberculosis of kidney.

In *Case* 43, the only lesion was a tuberculous nodule about half the size of a walnut, situated in the upper pole. The kidney was examined microscopically at the Queen's University, and pronounced to be tuberculous. The remainder of the kidney and the ureter were normal. I was half tempted here to do a partial nephrectomy, but, as I could not be entirely sure that the remainder of the organ was beyond reproach, I sacrificed the entire kidney. This is the only specimen I have yet seen in which the operation of partial nephrectomy might have been practicable. Pyonephrosis was a marked feature, especially in those cases with thickened ureter.

In *Case* 38, the organ was converted into a huge sac with thin walls containing tuberculous pus.

In *Case* 12, the enlarged kidney had a number of cavities filled with inspissated pus. This accounted for the rope-like discharge from the ureter, seen on cystoscopy. There was also a huge perinephritic abscess. The condition of the ureter varied somewhat. In some, as has just been mentioned, it was apparently quite normal, and showed no thickening or dilatation. In most, it was much thickened and narrowed, resembling a thick indiarubber tube, and was easily detected *per vaginam* or *per rectum*. In some, there was thickening and dilatation.

In *Case* 21, the ureter was dilated almost to the size of the small intestine, with several slight constrictions. The pelvis of the kidney was also enormously distended.

The vessels of the pedicle were in several cases reduced to impervious cords.

In *Case* 44, they did not require a single ligature, the only apparent blood-supply of the organ seeming to come from a vessel running from the neighbourhood of the spleen to the upper pole. The organ was so densely adherent to everything that the greatest difficulty was experienced in getting at the pedicle. The kidney was finally removed by shelling it out of its true capsule. In the attempts at removal, the suprarenal body was torn, and a portion of this structure was removed with the mass. In the kidney removed there were several ragged cavities containing malodorous pus, and the kidney substance was largely replaced by scar tissue. One point in the after-history of these cases deserves some notice, and that is the occurrence of a sinus along the track of the drainage tube, which

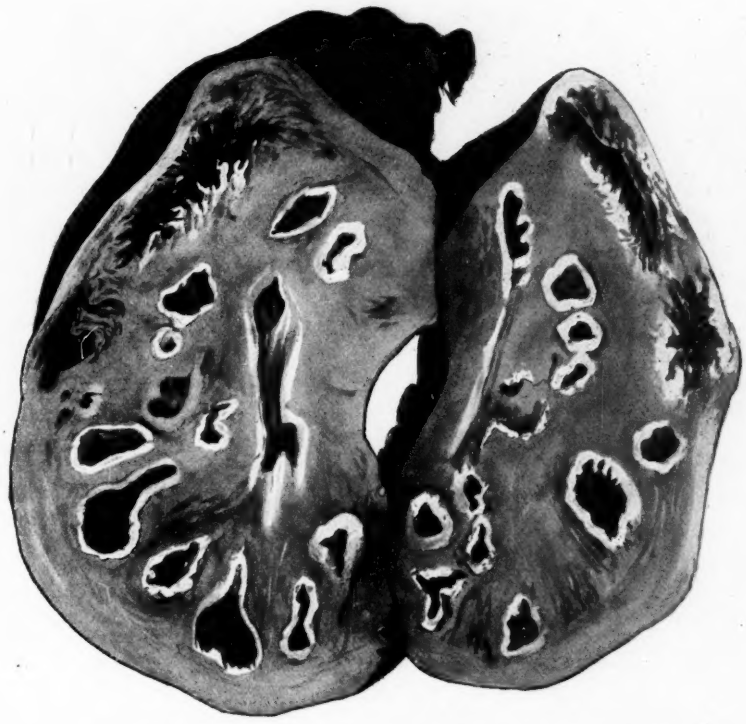


FIG. 101.—Tuberculosis of kidney, showing tuberculous nodules and ragged cavities.

may persist for months, and which may lead to subsequent infection of the whole wound. I have seen the operation-wound heal by first intention, except for the track of the tube, and subsequently break down, leaving a huge gaping cavity, defying for months all attempts at successful treatment. To avoid this sinus I have tried various expedients, such as dividing the ureter with the cautery as far down as possible, dissecting away as much of the perirenal tissue as practicable, and using absorbable catgut only for all ligatures. I mentioned this complication at the meeting of the British Medical Association, in Liverpool, in 1912, when the subject of genito-urinary tuberculosis was under discussion at the Surgical Section. The general opinion among the speakers seemed to be that

drainage ought to be dispensed with, and Mr. Hurry Fenwick, who opened the discussion, advised curettage of the interior of the stump of the ureter prior to ligature. In four recent cases I did not employ drainage. In one of these, *Case* 42, though the wound healed *per primam* in the first instance, it subsequently broke down completely. Two healed *per primam* and remained sound. In the fourth case, a little swelling occurred at one part of the wound and a small sinus formed, just as if a tube had been used. In most cases the sinus heals in a few weeks or months, but in others one's ingenuity is taxed to the utmost to obtain sound healing.

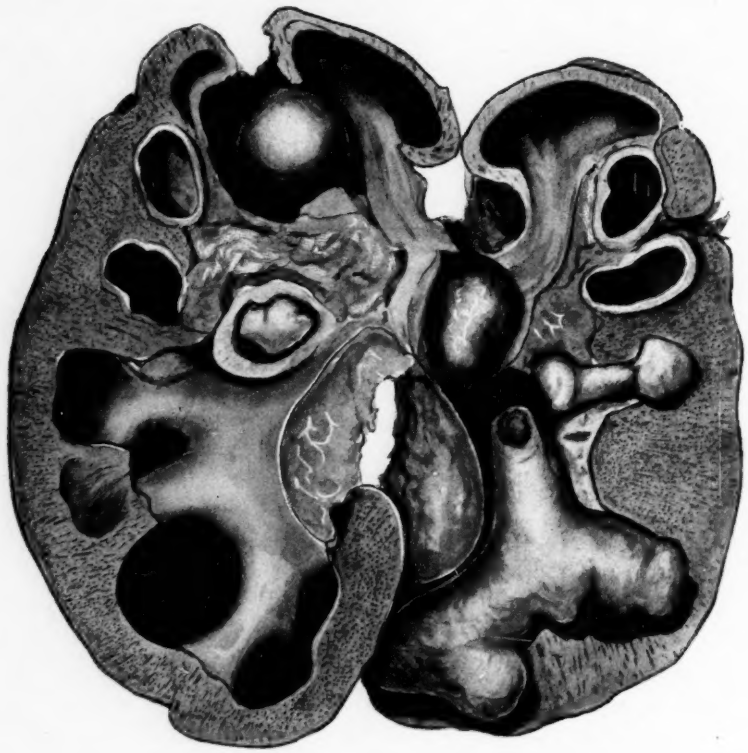


FIG. 102.—Kidney showing branched calculi in pelvis and calices: the smaller calculi have fallen out. The opposite kidney was converted into a cyst.

2. **Calculous Disease** (*Group B*), in which, from the presence of a calculus or calculi, the kidney seemed hopelessly destroyed. There were five of these cases, with one death. The fatal case illustrates so well the necessity of ascertaining the condition of the opposite kidney, that it deserves more than a passing notice (*see Case* 11). This patient, a male aged 53, had suffered for thirty years from pain in the right side, and hæmaturia. He had no pain on the opposite side. Examination with *x*-rays showed numerous calculi in the right kidney. There was an indistinct blurring in the photo from the left side, but no stones were visible. The photographs were not as satisfactory as those now obtainable, having been taken some years before *x*-rays in this district had reached perfection. The right kidney was explored, and found to be so profusely studded with stones,

which appeared to block up the pelvis and fill the calices, that on consultation with Mr. Howard Stevenson, who assisted me at the operation, I decided to remove it. It would have been useless to have attempted removal of all, or even most, of the stones and to have saved the kidney. The latter, on section, showed large calculi forming exact casts of the pelvis and calices, and in addition numerous round, flat, smaller calculi, brownish in hue, were found embedded in the smaller calices (*Fig.* 102). The large cast in the pelvis was in some parts translucent and smooth, like white marble. There was a good deal of sound kidney substance, evidently sufficient for the patient's needs, as the sequel showed. As the hours went on and the patient passed no urine, the catheter was introduced next morning, and about two ounces of urine were obtained f om the bladder. About twenty-nine hours after operation two ounces of blood-stained urine, with a sp. gr. of 1010, were passed. During the second day the patient vomited a good deal, and in the evening had a slight rigor. He looked well, however, and expressed himself as feeling well. On the third day, as no urine was being passed, I determined to explore the left kidney, thinking that I was, perhaps, dealing with a reflex anuria and that incision into the left kidney might save the patient. The organ was found converted into a large cyst, in the lower part of which a thin layer of true bone was found imbedded. In this portion of the cyst, occupying what appeared to be the dilated pelvis, several calculi were found. I could find no communication with the ureter. About ten ounces of fluid were evacuated from this cyst. The patient did not develop any very marked symptoms of uræmia. His pupils became contracted, he hiccoughed and vomited a little, but his pulse and temperature for several days kept about normal. Later he became a " little mixed " in his ideas, very restless, vomiting a little blood, the motions also being dark-coloured. His face became flushed, the veins standing out prominently. Later, he became semi-unconscious, and this condition deepened until he died quietly on the ninth day after his first operation. There were no convulsions, no marked delirium at any time, and no œdema in any part of the body.

In *Case* 8, a small stone was impacted in the ureter at its junction with the pelvis of the kidney. There was a groove in the stone through which urine could find its way into the distal ureter. The calculus had caused pyonephrosis, and had begun to ulcerate through the walls of the ureter, so that on manipulation the latter broke off at the weak spot.

In *Case* 40, the patient had had attacks of what was believed to be colipyelitis, with high temperature and pain in the right kidney. She had been having a vaccine of B. coli. On exploration, I found an oxalate of calcium stone encrusted with phosphates embedded in the pelvis, and evidences of commencing suppuration in the kidney substance. The organ was removed and reported by the University staff to be in an early stage of pyelonephritis or surgical kidney. In all these cases in which the sp. gr. of the urine on both sides was ascertained, it will be seen, by referring to the table, that there was a marked difference on the two sides.

3. **Pyelonephritis not associated with Stone** (*Group C.*)—There were two of these cases, with no deaths. In *Case* 36, a factory girl, aged 25, unmarried, two months before operation took a shivering fit and a " soreness " in the right lumbar region. At first she had pain during micturition, but later this passed off. She had no frequency. The patient had been losing flesh, and looked pale and ill.

The urine was acid, and contained abundant pus. The right kidney was enlarged and tender. Fever was present. With the cystoscope, the bladder was found to be normal, except for some swelling and relaxation of the right ureteric orifice. Pus exuded and blocked the ureteral catheter. The specimen from the left side was free from pus and blood, had a sp. gr. of 1010 (bladder specimen sp. gr. 1016), and contained a trace of albumin. At the operation there was found a foul-smelling perinephritic abscess. There was also an abscess in the upper pole of the kidney, and the ureter was much thickened, being about the diameter of an ordinary lead pencil. Great difficulty was experienced in detaching the kidney from its surroundings. The pedicle was short, and so adherent to the peritoneum that it was tied with great difficulty. Finally, after separate ligature of the vessels, it was found that the vena cava had been wounded. The rent in the vein was rapidly picked up with forceps and occluded by a catgut ligature passed round it, as one would tie a string round the neck of a sack. The kidney was twice the normal size, and the upper pole was hollowed out into a large abscess cavity with deeply congested ragged walls. On examination of the specimen, I found that I had removed the suprarenal body, which was closely incorporated with the kidney. The pathological report stated that the process was an inflammatory one unlike tubercle. Contrary to my expectations, the wound healed by first intention, except for the track of the drainage tube. It is interesting to note that, so far, the removal of the suprarenal body has not had any ill effect, and I have recently heard that the patient is quite well, more than a year after operation.

In *Case* 39, there was also a perinephritic abscess, and the kidney was enlarged and tender. The patient, a boy, aged 15 years, six weeks previous to my examination, was taken ill with vomiting, high temperature, and pain in the right lumbar region. At first, neither albumin nor pus was found, but later, pus appeared, and staphylococci were found in pure culture. The kidney, on removal, was found to be purplish in colour and exuded pus on section. In the centre of the organ there was a wedge-shaped area with the base towards the convexity, occupied by a number of small abscess cavities. The primary cause of this infarct was not evident. The pathological report stated that " sections from the kidney showed foci of inflammation and pus formation. At parts there was fibrosis or cicatrization, but no evidence of a tuberculous process . . . a case of pure staphylococcic infection." The patient made a good recovery.

4. **Pyonephrosis not due to Calculus** (*Group D*).—In *Case* 45, a thick ointment-like material was squeezed out through the ureteric orifice, and fell like worm-casts on the floor of the bladder. The urine had a foul odour. The kidney was distended with pus to the size of a cocoanut, and there was some dilatation of the ureter. This seems to have been a case of coli infection of the kidney during pregnancy, partial blocking of the ureter being produced by the thick pus. The bladder was healthy, and there was no frequency of micturition. The urine from the other kidney had a sp. gr. of 1015, and was free from albumin and pus. I had to resect the greater part of the last rib to remove the organ. Recovery was uneventful.

5. **Hydronephrosis** (*Group E*).—There were nine cases of hydronephrosis, with no deaths. The causes of the conditions were, so far as it was possible to ascertain, as follows :—

In *Case* 4, a tense rounded tumour, the size of a large melon, was found extending from the hypogastric region on the left side to the left lumbar region. With the cystoscope, a dark brown treacle-like material was pressed out of the left ureteral orifice at intervals. This consisted chiefly of blood mixed with pus. The urine from the right kidney had a sp. gr. of 1020, and contained a trace of albumin, with an odd granular cast. On removal, the kidney was found to be distended into a large cyst. The pelvis was dilated, but the ureter was normal from its junction with the former. I looked upon this case as one in which extreme mobility of the kidney had caused a kink of the ureter at its junction with the pelvis. The patient, a male, aged 27, had had trouble with his kidney for four years.

In *Case* 5 there was sudden narrowing of the ureter from the pelvis of the kidney downwards. Evidently this was a congenital malformation. The large sac-like kidney was intimately adherent to its surroundings, and was with much difficulty removed. The vessels were small. The artery was about the size of the radial.

In *Case* 14, the ureter joined the dilated pelvis at an angle, and there was a small opening into the attenuated ureter.

In *Case* 16, that of a medical man who was thought to have had appendicitis and had been operated on for that complaint, I found the right kidney distended into a huge cyst intimately adherent at its upper pole. The vessels of the hilum did not require ligature, being represented by impervious cords. The pelvis of the kidney was thin-walled and much dilated, and communicated with the ureter by a fine opening, just admitting the point of a small probe. The patient had B. coli in his urine, and had been having vaccine treatment for attacks of so-called coli-pyelitis.

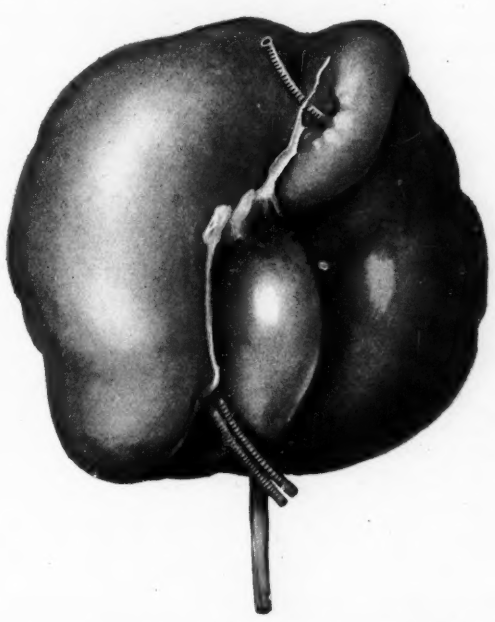


FIG. 103.—Kidney showing dilatation of the pelvis due to abnormal disposition of vessels.

In *Cases* 18 and 47, hydronephrosis was caused by an abnormal disposition of vessels (*Fig.* 103). In *Case* 18, an artery about the size of the ulnar crossed the lower pole in front of the ureter at its junction with the pelvis. The latter was dilated to about the size of a Tangerine orange, and the kidney was converted into a cyst. The ureter, from the point at which it was crossed by the artery, was diminished to the size of the vas deferens, but was pervious. In *Case* 47, the condition was caused by a vein and artery passing across the ureter at the level of the lower pole of the kidney. The ureter was about half the usual diameter below the point at which it was crossed by the vessels, but was, as in the last case, quite

pervious. A small artery was also found going to the upper pole. This patient had had his appendix removed for pain situated at McBurney's spot, with no relief to his symptoms.

In *Case* 22, the pelvis of the kidney was almost completely blocked by an oxalate of calcium stone, and there were about twenty others scattered through the various calices, which were much dilated. Some of these were typical specimens of mulberry calculi.

In *Case* 26, the right kidney was hydronephrotic, with a dilated pelvis. The ureter was also dilated as far down as I could reach. I could not determine the nature of the block.

In *Case* 33, the ureter joined a much-dilated pelvis on its anterior surface at an acute angle.

Case 34 was a female child, aged 3 years, in whom the family doctor found, accidentally, a tumour in the abdomen, during a routine examination. The child had no symptoms whatever. With the cystoscope, the left ureter was seen to be dry. I removed the kidney transperitoneally, through an incision in the outer part of the left rectus muscle. It proved to be a large transparent thin-walled cyst, with a thin and thread-like ureter which broke during manipulation. The distal part of the ureter was quite normal, and a probe could be passed down towards the bladder. The impervious portion occupied about an inch, and seemed to have a very flimsy connection with the kidney. The latter was a cyst about six inches long by three inches broad and deep, with a somewhat S-shaped bend at its upper pole in which a few nodules of kidney substance were found. The cyst was filled with a clear watery fluid. The remaining kidney was palpated and found to be free from cystic change.

In all these cases of hydronephrosis in which the sp. gr. of the urine of the sound side was determined, after ureteral catheterization, it was found to be 1015 or over, while that of the affected side was generally at or about 1005.

6. **Tumours of the Kidney** (*Group F*).—There were seven cases of renal tumour. All the patients recovered from the operation, but one died six weeks later, and will be further referred to.

In *Case* 7, the tumour was a typical example of what is known as hypernephroma, occupying the upper two-thirds of the organ, with a papilloma about the size of a pea projecting into one of the lower calices (*Fig.* 104). The patient, a woman aged 44 years, had attacks of pain and "swelling" in the left kidney, followed by hæmaturia, for about sixteen months. These attacks came on about once a fortnight, and lasted three or four days. As the growth had involved a large branch of the renal vein, I fully expected recurrence, but I find, on enquiry, that the patient remains well four and a half years after the operation. It is interesting to note that the sp. gr. of the urine on the affected side was 1015, as against 1020 on the sound side, thus bearing out the rule to which I have already referred. The difference on the two sides in these cases, however, is much less marked than in the groups just described. I would also direct attention to the fact that in several of these tumour cases pus was found on the affected side, while absent from the sound side. This is due, I believe, to a mild pyelitis, associated, no doubt, with the altered vascular conditions produced by the growth.

Case 13, a female, aged 51 years, had noticed, for about three or four weeks, that she had blood in her urine, and that there was swelling in the region of the

right kidney. On cystoscopic examination, a thick cord-like dark-coloured material was squeezed out of the right ureteral orifice and coiled itself like a rope on the base of the bladder. This thick substance could be seen to be pushed out at intervals. The urine from the sound side had a sp. gr. of 1025, and contained a trace of albumin. The kidney on removal was found to be occupied in its upper two-thirds by a tumour closely resembling that last described. I had to leave six pairs of artery forceps on the pedicle to control the bleeding, which was very profuse during the operation. The growth had involved the hilum of the kidney and rendered ligature of the vessel impossible. The patient

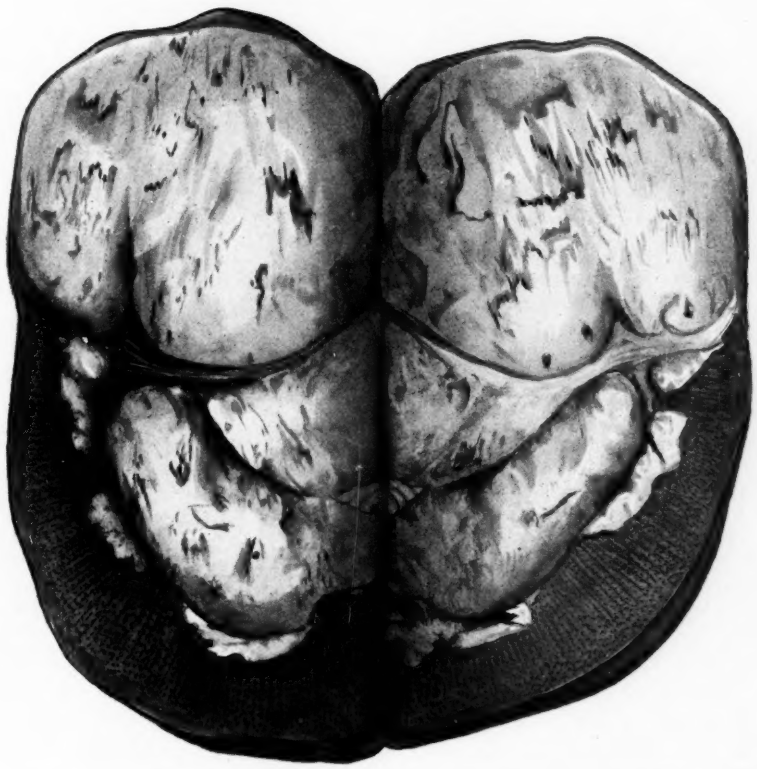


FIG. 104.—Hypernephroma occupying the upper two-thirds of kidney.

did well at first, but later became progressively weaker and anæmic. The left lower limb, and subsequently the right, became swollen and œdematous. The vertical glands in the left groin became enlarged, and the patient died six weeks after the operation. I was unable to obtain a post-mortem examination to satisfy myself as to the exact cause of death.

In *Case* 24, a man, aged 65, the symptoms were renal pain and hæmaturia for two months. The right kidney was just palpable. His ureters were catheterized, but, owing to the fact that he had had diuretics for some time previously, the sp. gr. was 1000 on both sides. There was, however, albumin on the affected side. The tumour was similar to those just described, and there was a small

papilloma the size of a pea in the pelvis of the kidney. The tumour occupied the upper pole of the organ. The patient died two years later from recurrence.

In *Case* 28, a similar tumour was found, and there was, in addition, a small calculus, about the size of a cherry-stone, in the pelvis of the affected kidney. The urine on the affected side had a sp. gr. of 1015, as against 1020 on the sound side. Albumin, a trace of blood, and some few pus cells were also found on the affected side. The symptoms were those of stone, and had lasted for about a year and a half before I saw him. *X*-rays showed the calculus and some enlargement of the kidney. The patient remains well one year after operation.

In *Case* 31, a little girl, aged 3 years and 2 months, bright red blood was noticed in the urine six days before I saw her. The child complained of pain during micturition, but there was no frequency. On examination, a large freely movable swelling could be felt in the left renal region. The cystoscope showed blood-stained fluid issuing from the left ureter, and clear fluid from the right. The kidney was removed by the transperitoneal route. The tumour was almost diffluent in parts, and the pelvis of the kidney was filled with growth. On section, about the centre of the organ a small piece of normal kidney remained. On microscopical examination the growth proved to be a sarcoma. Healing took place *per primam*, but the child died four months later from recurrence.

Case 32 was a lady, aged 60 years, who had suffered for a month or six weeks from renal colic and hæmaturia. The sp. gr. of the urine on the affected side was 1005, as compared with 1015 on the sound side. Operation was not undertaken until six months later. The kidney, on removal, showed a hypernephroma, about the size of a Tangerine orange, on the outer surface of the organ. The patient remains well a year and a half after operation.

In *Case* 46, a very stout man (I have been struck with the fact that in nearly all the cases in this group the patients have been stout), the history was very misleading. About twelve years ago he had what he calls terrific pain in his right side, passing down into the groin. A few days later, he passed blood and a small stone about the size of a pea. He says he has never been free from pain since. The urine on the affected side had a sp. gr. of 1015, and contained albumin, a small amount of pus, and some hyaline casts. That on the sound side had a sp. gr. of 1020, and was free from albumin and pus, though there were some hyaline casts: *x*-ray examination was negative. I fully expected to find a stone or stones in the kidney, but was surprised to see a large tumour occupying and replacing the lower two-thirds of the kidney. The last rib had to be resected to facilitate removal. The tumour was examined by Professor Symmers, who considered it to be a malignant adenoma. The patient has only recently been operated on, but is convalescent, and has left hospital.

7. **Urinary Fistula** (*Group G*).—There were two cases of urinary fistula in which I was obliged to remove the kidney.

In *Case* 25, a woman, aged 48 years, there had been an attack of what she called blood-poisoning about eighteen years before, after the birth of her third child. She developed a swelling on the left side, which was opened by a gynæcologist. Since then fluid had been discharging from a sinus in the loin. With the cystoscope, the left ureter was seen to open by a pin-point aperture into the bladder. During systole the vesical end of the ureter ballooned out so as to

appear like a translucent vesicle, and the efflux was mixed with whitish specks. It was impossible to get a ureteral catheter into the orifice. Clear urine was obtained from the right side. This was of low sp. gr., but the catheter specimen from the bladder, taken just before the examination, had a sp. gr. of 1015. In the hope of curing the sinus, I incised the orifice of the stenosed ureter through a vaginal wound. As this procedure failed to cure the sinus, I was obliged to remove the kidney, which was atrophied and densely adherent to the surrounding parts.

In *Case* 35, I explored the left kidney and ureter for severe pain. No cause could be found, though I suspected a small stone, and a urinary fistula persisted. After trying various expedients to get rid of the sinus in the loin, I was at last obliged to remove the kidney.

In conclusion, I should like to emphasize the necessity for accurate diagnosis before any operation on the kidney is undertaken. I have mentioned the case of calculous disease, in which I removed the only functioning kidney the patient possessed, as a warning to the haphazard operator. Again, the painful kidney may not be the one at fault, as would appear from the following case which has just come under my notice. A man, aged 49 years, noticed three months ago that his urine was tinged with blood. About the same time he began to suffer from attacks of pain in the *left* side. I fully expected to find the blood issuing from the left ureter. On the contrary, the specimen obtained by ureteral catheter from that side was perfectly normal, while the *right* efflux was deeply tinged.

I would also strongly deprecate the removal of a kidney which is bleeding if no obvious disease can be found in it on exploration. The kidneys may alternate in bleeding, as happened in the following case. A sailor, aged 30 years, after a slight accident, suffered from hæmaturia without pain. He was seen by Professor Rovsing, of Copenhagen, who found blood coming from the right ureter. Professor Rovsing cut down on the *right* kidney, expecting to find a rupture going into the pelvis, or perhaps an aneurysm of one of the branches of the renal artery. The only abnormality found, however, was a number of adhesions between the kidney and its surroundings. The bleeding continued for three weeks after the operation, and then cleared up for four days. Again it recurred and lasted another week, and then disappeared for three or four weeks, when it again came on as bad as ever. I examined him during this period, and found blood coming from the *left* side. The specimens obtained by ureteral catheter from the right side were quite normal. Three years later I again examined this patient, who had been bleeding off and on ever since my first examination. I now found that the bleeding was from the *right* side. Here we have a case of alternating renal hæmaturia probably due to some obscure form of nephritis. I need hardly point the moral in this case. I have seen a kidney removed for hæmorrhage which, when examined by a skilled pathologist, showed no changes sufficient to justify its sacrifice.

The value of careful examination is well shown in the following case, which I saw in Sligo four years ago. This was a woman with a large, hard, somewhat nodular swelling in the region of the right kidney. Pus exuded from the right ureteral orifice, and clear urine from the left. I placed a catheter into the left, and drew off some of the clear urine for examination. It had a sp. gr. of 1020,

but contained a large amount of albumin and many casts. I was not prepared for this from the general appearance of the patient. I declined to operate. The patient died a month later from uræmia.

CONCLUSIONS.

1. The mortality of nephrectomy has diminished in recent years owing to the more efficient means of early diagnosis at our disposal, and especially to the more accurate information obtainable by means of the ureteral catheter.

2. In most cases of unilateral disease of the kidneys the urine of the affected side will be found to have a diminished specific gravity. This is due in the early stages to increased flow of blood through the organ caused by irritants such as calculus and tubercle. In later stages, it is due to inability of the kidney to separate the solid constituents of the urine from the blood. In advanced cases, ropes of inspissated pus or blood may replace the fluid efflux.

3. It is not good surgery to remove a diseased kidney until satisfactory evidence has been obtained as to the functional capacity of its fellow.

4. If the urine obtained from the presumably sound side has a specific gravity of 1015 or over, is passed in sufficient quantity, and is free from albumin, pus, and blood, it is reasonably safe to remove the affected organ.

CASES OF NEPHRECTOMY

No.	Sex and Age	Disease	Main Symptoms	Results of Examination
GROUP A.				
1	F 36	Tuberculous Kidney, right	Scalding in urethra during micturition	R. sp. gr. 1005, pus
2	F 25	,, ,, ,,	Slight freq. of mict. and scalding	R. sp. gr. 1005, pus
3	M 47	,, ,, ,,	Renal pain on right side	R. pale, pus
6	M 25	,, ,, left	Renal pain on left side	.. .. ..
9	F 25	,, ,, right	Frequency of micturition	R. no flow
10	M 40	,, ,, ,,	Renal colic and freq. of mict.	R. sp. gr. 1005, pus
12	M 36	,, ,, left	Renal colic and renal swelling	R. sp. gr. 1020, no pus
15	M 38	,, ,, right	Freq. of mict. and scalding	R. sp. gr. 1005, pus
17	F 24	,, ,, left	Freq. of mict. and meatal pain	R. sp. gr. 1020, no pus, trace of alb
20	M 24	,, ,, ,,	Freq. of mict. followed later by renal colic	R. sp. gr. 1020, no pus, trace of alb
21	F 29	,, ,, right	Scalding in urethra and frequency of mict.	R. a few drops with pus
23	F 22	,, ,, ,,	Scalding, freq. of mict. and renal pain	R. nil
27	F 26	,, ,, left	Scalding and freq. of mict.	R. sp. gr. 1015, no pus
29	F 43	,, ,, ,,	Noticed sediment in urine; no other symptom	R. sp. gr. 1015, no pus, no alb.
30	M 26	,, ,, ,,	Freq. of micturition	R. clear and free from pus and alb.
37	F 41	,, ,, right	Freq. of mict. and renal pain	R. sp. gr. 1000, pus
38	F 17	,, ,, left	Freq. of mict. and pain after mict.	R. sp. gr. 1020, no pus, alb. present
41	F 31	,, ,, ,,	Aching in renal region	R. sp. gr. 1020, no pus, no alb.
42	M 39	,, ,, right	Freq. of mict. and penile pain	.. .. ..
43	M 26	,, ,, left	Renal colic	R. sp. gr. 1020, no pus, no alb.
44	F 26	,, ,, ,,	Freq. of mict., followed later by renal pain	R. sp. gr. 1015, no pus, trace of alb.
48	F 30	,, ,, ,,	Renal pain, followed later by freq. of mict.	R. sp. gr. 1010, no pus, no alb.

* The sp. gr. in most of these cases was taken wit

5. A trace of albumin, or a few pus or blood cells in the urine from the presumably sound side, provided the specific gravity is not too low, need not necessarily preclude operation, other conditions being favourable.

6. Removal of a bleeding kidney not obviously diseased ought never to be carried out except as a last resort to save life. If possible, careful and repeated examinations should be made, in order to exclude the possibility of alternate bleeding.

7. A patient may have renal pain on one side and hæmaturia from the other kidney. It must not, therefore, be assumed that the painful side is necessarily the seat of the hæmorrhage.

8. The accidents that are liable to occur during the operation of lumbar nephrectomy are: hæmorrhage, from difficulty in securing the pedicle or from injury to the vena cava; injury to the pleura or peritoneum; interference with the blood supply of the colon, leading later to fæcal fistula; and laceration, or complete removal, of the suprarenal body, when extensive adhesions bind it to the kidney.

REFERENCE.

[1] *Ann. Surg.* July, 1912.

BY MR. ANDREW FULLERTON.

WITH URETERAL CATHETER *	RESULT OF OPERATION	REMARKS
L. sp. gr. 1015, no pus, no alb.	Recovery	Remains well six years later.
L. sp. gr. 1020, no pus, no alb.	,,	Died from pulmonary tuberculosis and tuberculous meningitis a year later.
L. sp. gr. 1010, no pus, no alb.	,,	Remains well 5½ years later.
.. .. ..	,,	Lost sight of.
L. sp. gr. 1015, no pus, trace of alb.	,,	Remains well 3½ years later.
L. sp. gr. 1020, no pus, trace of alb.	,,	Remains well 4 years later.
L. ropes of pus squeezed out	Died	Had a perinephritic abscess.
L. sp. gr. 1015, no pus	Recovery	Remains well 3½ years later.
L. sp. gr. 1005, pus	,,	Well when last heard of one year later.
L. sp. gr. 1005, pus	,,	Died about a year later. Tuberculous ulceration of intestine.
L. sp. gr. 1015, no pus, no alb.	,,	Had tuberculous peritonitis 9 months later, but has recovered, and is well, 2½ years after operation.
L. sp. gr. 1005, no pus	,,	Well when last heard of a year later.
L. sp. gr. 1005, pus	,,	Remains well nearly two years later.
L. ropes of pus squeezed out	,,	Remains well nearly two years later.
L. sp. gr. 1010, pus and alb.	,,	Remains well nearly two years later.
L. sp. gr. 1015, no pus, no alb.	,,	Remains well nearly one year later.
L. sp. gr. 1005, pus	Died	Albumin was present on right side.
L. nil	Recovery	Remains well nearly one year later.
.. .. ..	,,	Doing badly some months later. Had developed pulmonary phthisis and pleurisy.
	,,	
L. sp. gr. 1015, a few pus cells	,,	This was a small deposit in upper pole of left kidney. Well 6 months later.
L. not catheterized	,,	Remains well 6 months later.
L. sp. gr. 1005, pus and alb.	,,	Recently operated on.

glass beads, and is therefore only approximate.

[*Continued on next page.*

CASES OF NEPHRECTOMY BY MR.

No.	Sex and Age	Disease	Main Symptoms	Results of Examination
GROUP B.				
8	F 56	Calculous pyonephrosis, left	Bladder irritability	R. sp. gr. 1015, no pus, no alb.
11	M 53	Extensive Calculous disease, right	Renal colic	*Condition of left kidney*
19	M 34	,, ,, ,,	,, ,,	R. sp. gr. 1005, pus and alb.
22	M 30	,, ,, left	Renal colic and bladder irritability	R. sp. gr. 1015, no pus, no alb.
40	F 48	,, ,, right	Renal colic and attacks of fever	R. sp. gr. 1000, pus and blood
GROUP C.				
36	F 25	Pyelonephritis, right	Pain and swelling in renal region	R. thick pus (bladder spec. sp. gr. 1016)
39	M 14	,,	Pain in renal region, vomiting and fever	.. .. ..
GROUP D.				
45	F 22	Pyonephrosis, left	Renal pain and swelling, fever	R. sp. gr. 1015, no pus, no alb.
GROUP E.				
4	M 27	Hydronephrosis, left	Painful recurring renal swelling	R. sp. gr. 1020, no pus, trace of alb.
5	F 36	,, ,,	Frequent attacks of renal pain and swelling	R. sp. gr. 1015, no pus, no alb.
14	M 21	,, ,,	Frequent attacks of renal pain and swelling	R. sp. gr. 1020, no pus, trace of alb.
16	M 35	,, right	Pain attributed to appendicitis: appendix had been removed	R. nil
18	M 25	,, left	Attacks of renal colic	R. sp. gr. 1025, no pus, no alb.
26	M 21	,, right	,, ,,	R. nil
33	M 25	,, left	Pain in side and frequency of mict.	R. no alb., no pus, no blood
34	F 3	,, ,,	Tumour left side, no symptoms	.. .. ..
47	M 26	,, right	Pain attributed to appendicitis: appendix had been removed	R. sp. gr. 1005, pus and alb.
GROUP F.				
7	F 44	Hypernephroma, left	Lumbar pain and hæmaturia	R. sp. gr. 1020, trace of alb.
13	F 51	,, right	Renal swelling and hæmaturia	R. thick dark rope pushed out
24	M 65	,, ,,	Renal colic and hæmaturia	R. sp. gr. 1000, alb. present
28	M 49	,, left	Lumbar pain in left side	R. sp. gr. 1020, no alb., no pus
31	F $3\frac{2}{12}$	Sarcoma, left	Hæmaturia	.. .. ..
32	F 60	Hypernephroma, right	Renal colic and hæmaturia	R. sp. gr. 1005, blood
46	M 52	Malignant adenoma, right	Renal colic of 12 years' duration, hæmaturia	R. sp. gr. 1015, pus, hyaline casts and alb.
GROUP G.				
25	F 48	Urinary fistula in loin, left	Discharge of urine, and pain in loin	R. sp. gr. 1005, no alb., no pus, bladder specimen sp. gr. 1015
35	M 37	,, ,, ,,	Discharge of urine in loin	R. sp. gr. 1015, no alb., no pus

* The sp. gr. in most of these cases was taken with

MR. ANDREW FULLERTON—*continued*.

WITH URETERAL CATHETER *	RESULT OF OPERATION	REMARKS
L. sp. gr. 1002, pus and alb.	Recovery	Remains well 4½ years later.
unfortunately not ascertained	Died	Left kidney converted into a cyst.
L. sp. gr. 1020, no pus, no alb.	Recovery	Well when last heard of a year later.
L. sp. gr. 1005, pus	,,	Remains well 2½ years later.
L. sp. gr. 1020, no pus, no blood	,,	Remains well one year later.
L. sp. gr. 1010, no pus, trace of alb.	Recovery	Vena cava injured, remains well 1½ years later.
.. .. ..	,,	Remains well one year later.
L. thick pus	Recovery	Remains well six months later.
L. sp. gr. 1010, pus and blood	Recovery	Well when last heard of.
L. nil	,,	,, ,,
L. sp. gr. 1005, alb., pus and blood	,,	,, ,,
L. sp. gr. 1015, no pus, no alb.	,,	Remains well 3½ years later.
L. sp. gr. 1005, casts present	,,	Well when last heard of.
L. sp. gr. 1020, no pus, no alb.	,,	,, ,,
L. nil	,,	,, ,,
.. .. ..	,,	,, ,,
L 1020, no pus, trace of alb.	,,	,, ,,
L. sp. gr. 1015, trace of alb., a few pus and blood cells	Recovery	Remains well 4½ years later.
L sp. gr. 1025, trace of alb.	,,	Died 6 weeks later from œdema of legs and asthenia
L. sp. gr. 1000, no alb. (diuretics)	,,	Died 2 years later from recurrence.
L. sp. gr. 1015, trace of alb.	,,	Remains well 1 year later.
.. .. ..	,,	Died from recurrence 4 months later.
L. sp. gr. 1015, no blood, pus or alb.	,,	Remains well 1½ years later.
L. sp. gr. 1020, no alb., no pus, hyaline casts	,,	Recently operated on.
L. nil	Recovery	Still complains of pain in loin.
.. .. ..	,,	Remains well 1½ years later.

glass beads, and is therefore only approximate.

RECENT ADVANCES IN THE SURGERY OF THE LUNG AND PLEURA.

By H. MORRISTON DAVIES, London.

INTRODUCTION.

The surgery of various parts of the body has always been subject to fitful periods of stagnation alternating with periods of progress, set going usually by some new discovery as to the nature of a disease or by some development in general technique. For the intrathoracic region the inactive period has been a very long one, and it is only within the last decade that the change has come. Yet so marked is this change, so rapid the progress which is being made, that although previously, few conditions other than some of the acute inflammatory ones were dealt with by surgical measures, at the present time there is scarcely an intrathoracic lesion, from bronchitis and emphysema to carcinoma of the lung, which does not yield a steadily increasing proportion of satisfactory and encouraging results to the new methods of active treatment.

Many who have not followed closely modern advances in the surgery of the lungs, have erroneously conceived the idea that the progress has been exclusively in the technique allowing of operations in the open chest. The realization by Sauerbruch and Brauer of their endeavour to discover the means of overcoming the dangers of operating with an uncompensated pneumothorax has undoubtedly greatly facilitated the surgical treatment of certain groups of intrathoracic diseases. The total number of cases, however, in which this technique is necessary is quite small compared with the great number of patients who have benefited by modern progress. The result of such progress has been the emergence of three main lines of treatment, which may be termed: (1) Treatment by collapse; (2) Treatment by consolidation and fibrosis (solidification); (3) Treatment by excision.

Treatment by collapse is the most striking advance in pulmonary surgery in that it is applicable to many pathological conditions and is an entirely original procedure applicable to no other part of the body.

DIAGNOSIS.

As a natural sequel of the possibilities of progress in treatment, attention has been recalled to the necessities of early and precise diagnosis.

The advance in this direction has also been very considerable owing mainly to the great improvement in technique and in the interpretation of radiography, and to the realization of the immense value of the *x*-rays in furnishing definite and detailed evidence of intrathoracic conditions.

Such widely different diseases as mediastinal tumours, aneurysms, tubercle, streptotrichosis, syphilis, and tumours of the lung, may for long periods present the clinical picture of a bronchitis: deep-seated lesions often give no signs, specially when there is emphysema; patients with syphilis or streptotrichosis

have not infrequently been treated for weeks at sanatoria. Yet all these conditions are recognizable easily and early by means of radiography.

It is still quite frequently said that radiography is of little value. That is true just so long as the radiogram is indifferent and the individual unskilled in the interpretation of the shadows.

While our knowledge is still incomplete in many particulars, yet there are many of the clinical problems which can be solved at once. The difference between fluid and consolidation of the lung, between pneumonia and pneumothorax, the extent of a tuberculous lesion, the advance or healing of phthisis, can all be recognized by radiography, and it is by far the most accurate method of recording the progress of a disease.

It may be said emphatically that no diagnosis of any intrathoracic lesion can be complete until a radiological examination has been made.

THE THERAPEUTIC USE OF GASES IN THE PLEURAL CAVITY.

When air is introduced into the pleural cavity the oxygen is rapidly absorbed, but the nitrogen and carbon dioxide remain for a much longer period. Murphy[1] injected nitrogen into the chest, and found by means of radiography that at the end of five weeks there was scarcely an appreciable diminution of the quantity of gas, and it has been shown more recently that in whatever proportion the three principal gases of the atmosphere are introduced into the pleural cavity, the composition of the gases still present after about five days is some 96 per cent of nitrogen and 4 per cent of carbon dioxide.[2]

It is for these reasons then that when it is required to produce and maintain collapse of the lung for therapeutic purposes, as in phthisis, nitrogen gas is used, but when the object is to replace fluid and obtain expansion of a collapsed lung, oxygen is introduced.

Nitrogen Displacement for Pulmonary Tuberculosis.—The value of rest to a lung extensively affected with phthisis had long been observed in cases where a pleural effusion had developed during the course of the pulmonary lesion and produced compression of the lung; the improvement in the condition of those phthisical patients who survived a spontaneous pneumothorax, the result of rupture of a cavity, had often been recorded. Carson, as early as 1821, recommended the production of a pneumothorax in cases of pulmonary tuberculosis, and Forlanini even propounded the theoretical value of this procedure in 1882. But it was not till ten years later that Forlanini put his views into practice and established a pneumothorax as a therapeutic method in pulmonary tubercle. In 1898, Murphy independently adopted the same form of treatment.

The Choice of Case.—It was at first thought that this method of treatment was applicable to cases of unilateral phthisis only, but it is now realized that a slight amount of disease in the opposite lung is no contraindication. The most important fact to be ascertained as regards the least affected side is that there is sufficient healthy lung tissue to carry on the work of aerating the blood after the opposite lung has been put out of action by the pneumothorax.

As the production of an artificial pneumothorax is not entirely devoid of

risk, it is advisable not to adopt this method of treatment until the patient has had a reasonable course (about two months) of hygienic and tuberculin treatment, and it has been found by clinical and radiographical evidence that the lesion is not showing definite signs of clearing up.

Cases in which the disease appears as an acute and rapidly progressing miliary tubercle or as a caseating pneumonia are not suitable for this form of treatment. When, however, the disease is chronic and progressive despite the ordinary forms of treatment; when particularly there are cavities which cannot collapse owing to the rigid chest wall, except by extensive fibrosis of the lung; when the secondary pyogenic infection is marked, or when hæmoptysis is profuse or repeated, the collapse of that lung by artificial pneumothorax will very materially improve the general condition of the patient, and may in a considerable number of cases result in a complete cure of the lesion.

Technique.—During the actual production of a nitrogen pneumothorax two grave complications must be guarded against. These complications, both of which may end fatally, are:—(1) *Nitrogen embolus;* (2) *The train of symptoms known as "pleural eclampsia" or the "pleural reflex."*

Nitrogen embolus is due to the needle entering the lung and the gas escaping into a blood-vessel. The "pleural reflex" may be caused by the needle puncturing the pleura, by the introduction of nitrogen under excessive pressure in a part of the pleural cavity localized by adhesions, and the resultant drag on these adhesions, or by the rupture of adhesions. Previous uneventful puncture of the pleura or the rupture of adhesions offers no guarantee that the reflex will not occur on a subsequent occasion. The phenomenon manifests itself usually as a syncopal attack, with partial or complete loss of consciousness, marked restlessness, pallor, and disappearance of the radial pulse. The symptoms usually disappear in a few minutes, but death may ensue. Both these dangers can be avoided, in the author's opinion, by suitable precautions.

To eliminate the possibility of a "pleural reflex," the parietal pleura must be anæsthetized, preferably with novocaine, at the point of puncture. The risk of gas embolus can be obviated by using the technique advocated by Brauer,[3] who exposes the pleura through an incision of 5 to 7 cm., and thus is able to see that the needle perforates parietal pleura only. A much simpler and equally safe method is to connect the needle with a water manometer, as advocated by Forlanini,[4] and never to introduce the gas unless the oscillations of the manometer synchronizing with the movements of respiration indicate indubitably that the opening of the needle is in the pleural cavity. A mercury manometer is valueless, as the excursions are too small. The water manometer is further an invaluable guide throughout the whole injection, as it records continuously the variations in degree of the intrapleural pressure. It will denote the presence of dense adhesions round the needle by recording a rapid rise of pressure in the space so confined, with a diminution of the oscillations. The presence of soft yielding adhesions is shown by the registration of a moderate positive pressure, the fluid in the manometer recording, in addition to the regular respiratory oscillations, irregular bigger variations as the pleural surfaces are gently forced apart.

Once an air space has been produced in the pleural cavity, subsequent injections are devoid of all risk of an embolus, unless during the deliberate rupture of adhesions by the production of a high intrapleural pressure (a most

dangerous proceeding) the lung is torn, and nitrogen escapes into the pulmonary circulation. The greatest danger exists at the first attempt, and to minimize this still further it is advisable that the first 100 c.c. of gas introduced should be oxygen.

Brauer injects from 500 to 1000 c.c. of nitrogen on the first occasion, and somewhat larger amounts on each subsequent occasion. Forlanini recommends the introduction of about 200 c.c. only to begin with, and this is certainly a preferable quantity, as the partial collapse of the lung causes a variable degree of auto-inoculation, and an excessive dose may produce marked reaction and even

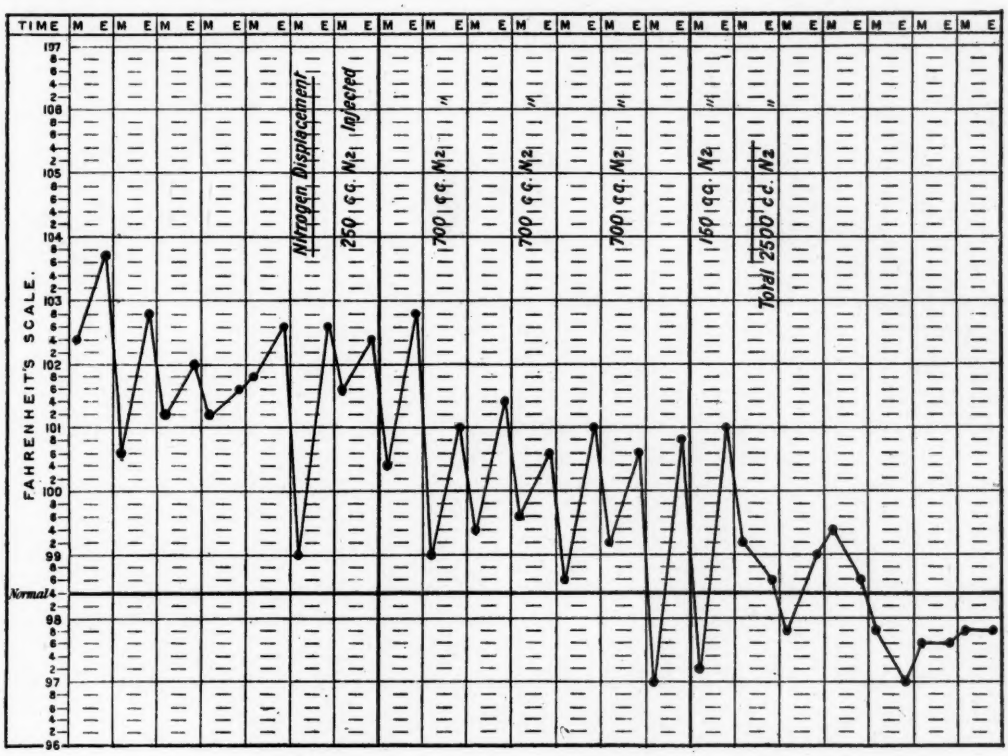


FIG. 105.—TEMPERATURE CHART OF A CASE OF PHTHISIS TREATED BY PNEUMOTHORAX.

an acute extension of the phthisis. If there is a reaction the next dose should not be given until the temperature has been steady again for at least three days. Subsequent doses may be increased to 700 or 1000 c.c., but the amount is regulated by the condition and comfort of the patient. The pleural cavity of an adult will tolerate about 3000 c.c. of gas.

If the pneumothorax is undertaken to check hæmoptysis, the amount introduced on each occasion may be greater, and the injections should be made daily instead of on alternate days.

Complications.—Whenever possible, the progress of the collapse must be controlled by frequent *x*-ray examinations. Besides the dangers of "pleural reflex" and gas embolism already described, two other complications may arise, sepsis, and pleural effusion.

Pleural effusion develops in about 15 to 20 per cent of cases as a direct result of the introduction of the nitrogen. It is not great as a general rule, and need not give rise to much anxiety. It must be remembered, however, that the effusion may develop or increase after the lung has been completely collapsed, after, that is to say, the pressure in the intrapleural cavity has been raised to the maximum desired. In these circumstances the additional displacement of the heart and mediastinum, and the added pressure applied on the sound lung, may produce both respiratory and cardiac embarrassment.

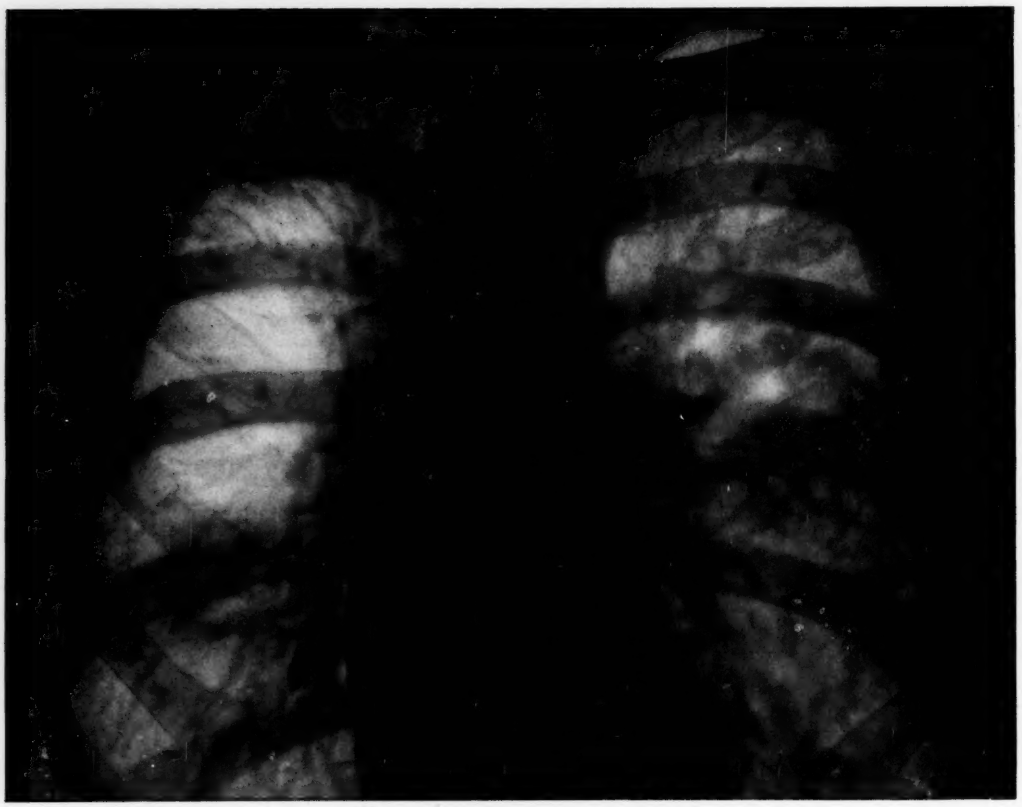


FIG. 106.—A CASE OF PHTHISIS.

On the right side the upper and middle lobes are involved. There is a cavity in the upper lobe below the level of the clavicle. Left side shows general peribronchial invasion. A pneumothorax was produced on the right side.

The distress thus occasioned is easily relieved by the withdrawal of some of the air or fluid.

Results.—It is generally recognized by all who have had experience in the treatment of phthisis by nitrogen pneumothorax, that the results obtained by this method are most encouraging. The improvement in the patient in properly selected cases is immediate and often startling, whilst the effect of the treatment in arresting the disease is equally gratifying.

The changes which are to be observed during the initial period of the treat-

ment are at first possibly an increase in the cough and expectoration, followed by a marked diminution and even disappearance of these symptoms, and a subsidence of the fever. With these, naturally follows improvement in the general condition of the patient; sleep is more easily obtained, and the appetite improves. In the chart (*Fig.* 105) shown on p. 231, the first part is typical of the temperature variations for the two previous months. Associated with the return to normal, the cough and expectoration both ceased, though previously from 3 to 5 oz. of sputum had been brought up daily.

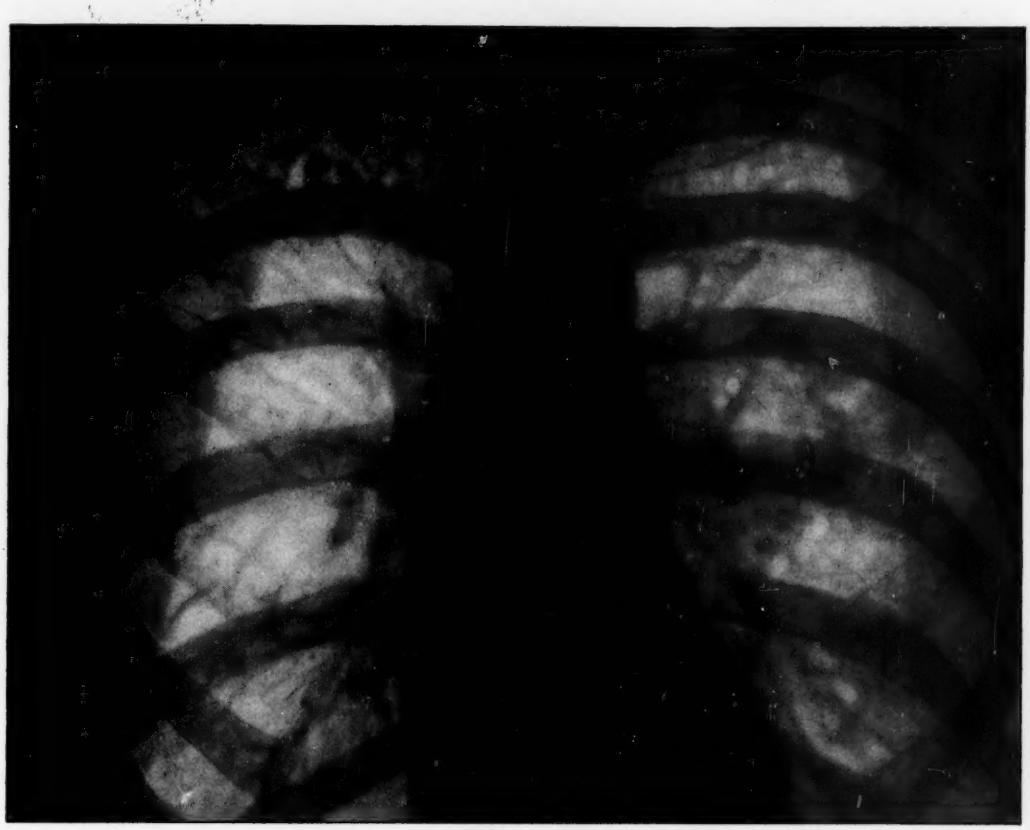


FIG. 107.—THE SAME CASE AS *Fig.* 106, TAKEN TWO MONTHS LATER.
Note the marked improvement that has taken place, not only in the re-expanded right lung, but also in the left lung.

After eight to ten weeks, the nitrogen becoming absorbed, the lung re-expands, and the improvement in the pulmonary lesion—the fibrosis which denotes the healing of the tuberculous foci, the obliteration of the cavities, and the disappearance of the surrounding pneumonic areas—can be clearly seen and recorded by radiography.

As it is usually necessary to maintain the displacement of the lung for about a year, fresh injections of nitrogen must be made every two to three months.

Except by a few dissentients, it is generally accepted that tuberculous

lesions in the uncollapsed lung tend also to heal as a result of pneumothorax on the opposite side. The two radiograms (*Figs.* 106 and 107; see also *Fig.* 115)

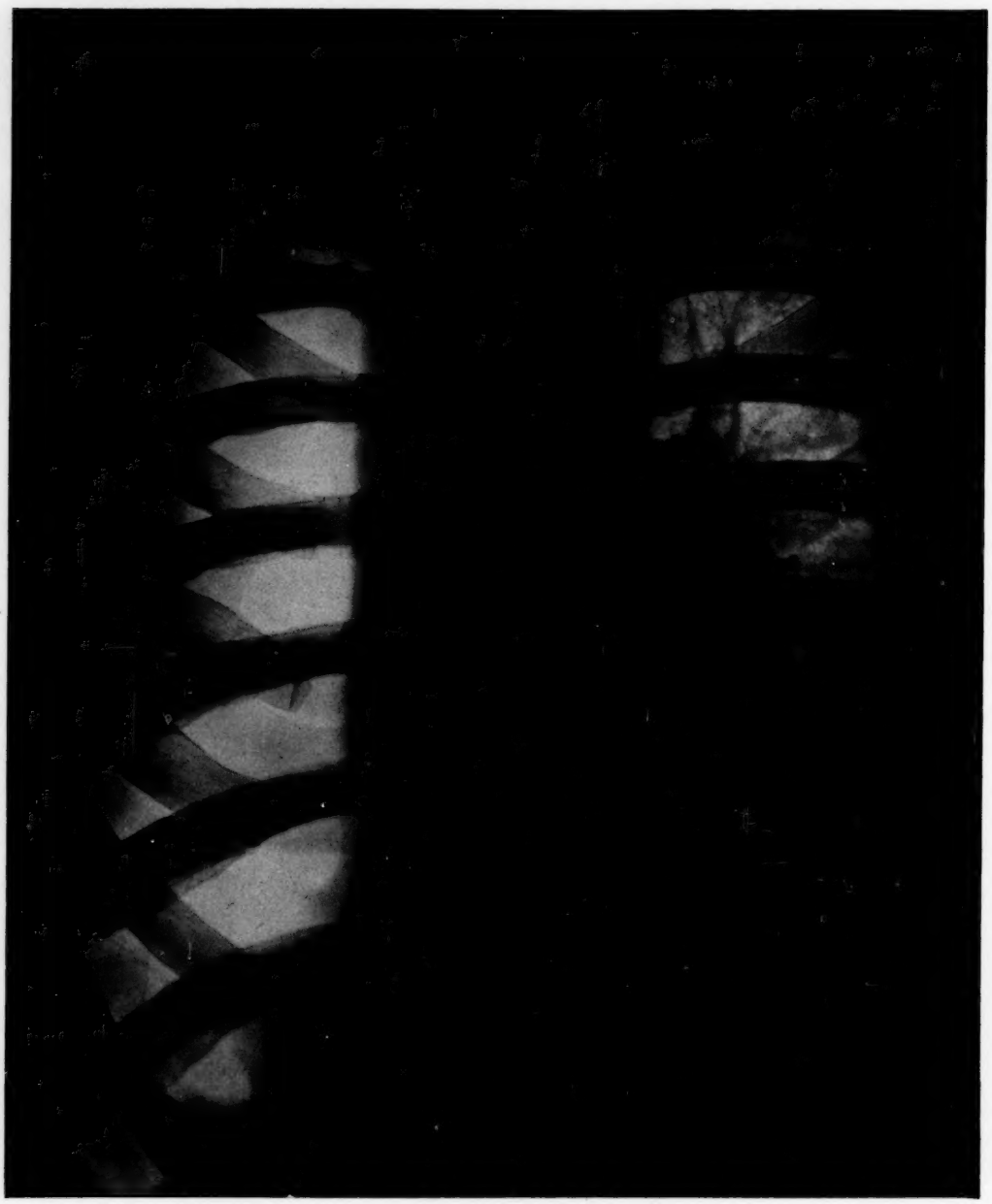


FIG. 108.—THE SAME CASE AS *Fig.* 113.
Production of artificial pneumothorax as a preliminary to extensive thoracoplasty.

taken, the one immediately before the introduction of nitrogen and the other after an interval of two months, show the change very clearly. This patient

had been under observation for two months before the penumothorax was produced, and the tuberculous foci had progressed rapidly during that period.

The surgical treatment of pulmonary tuberculosis, when the adhesions between the pleural membranes prevent lung collapse by nitrogen pneumothorax, will be discussed later.

Nitrogen pneumothorax has been tried also in the treatment of bronchiectasis and putrid bronchitis. The records of treatment in the latter complaint are not many, but great improvement and even cure have been recorded. The method certainly offers considerable possibilities for the relief of the disagreeable symptoms of this disease. Probably it can be of real value in unilateral cases only.

The results in bronchiectasis, compared with the operation of causing collapse of the chest wall, are disappointing. Improvement has been obtained in many cases, but it is temporary only, and when the lung re-expands the symptoms return. As a preliminary measure to the collapse of the chest-wall, however, a pneumothorax should be produced when possible, as it diminishes the cough, the amount of sputum, and the septic absorption, and also lessens the risk of suddenly flooding the air-passages when the subsequent thoracoplasty is done (*Fig.* 108).

Oxygen Replacement.—It has long been recognized that aspiration of fluid is not devoid of danger, and that the symptoms of distress after the withdrawal of four, three, or even two pints may be considerable. It must often, moreover, have caused a sense of disappointment that so few fresh physical signs appear over the lower lobe after paracentesis. Radiography has shown us that the reason of this is the comparatively large amount of fluid that still remains in the pleural cavity, obscuring not only the physical signs but also the details of the lung in the radiogram.

Air and even oxygen have occasionally been introduced to facilitate the withdrawal of fluid, but the importance of the exact regulation of the intrathoracic pressure has not been recognized till recently.

The author has shown that if during paracentesis, whenever there is the slightest symptom of distress, 100 c.c. of oxygen are allowed to flow in to the chest, "the operation (of paracentesis) can be performed with a minimum of discomfort to the patient, and without the occurrence of those symptoms of distress so commonly manifested towards the conclusion and often lasting for some time afterwards; that the whole instead of a portion only of the fluid can be withdrawn; and that the lung can be cleared so as to permit of complete radioscopy and radiography."

The aspiration is done with the ordinary needle and cannula, pump and bottle, in which the vacuum is produced. The hollow needle for the gas is connected with the gas apparatus such as is used for producing a penumothorax in phthisis, but filled with oxygen instead of nitrogen. The needle must, however, have a bore of at least 1 mm., in order that the intrapleural variations of pressure may be transmitted through the fluid which surrounds the opening of the needle. The cannula for aspiration is introduced into the lowest accessible part of the fluid, and the needle connected with the oxygen some two interspaces higher up.

The fluid is drawn off until the first indication of discomfort to the patient is noticed, when the aspiration is instantly stopped and 100 c.c of oxygen are slowly allowed to flow into the pleural cavity. Aspiration is then resumed till the appearance of a slight degree of pain or cough indicates that another 100 c.c. of oxygen must be let in. This alternation of withdrawing fluid (or towards the end fluid and oxygen) and introducing oxygen, is continued till the aspirator sucks out oxygen only, when a final 100 c.c. of oxygen are run in to lower the high negative pressure.

The method of oxygen replacement has further advantages. If the pleural cavity is filled with oxygen, this is rapidly absorbed and increases the intrapleural negative pressure; but at the same time, though less quickly, there is an exchange of gases, nitrogen and carbon dioxide replacing the oxygen. These in their turn tend slowly to be absorbed, and so a steady traction is maintained on the surrounding structures. If a lung has been compressed by fluid, and, owing to the thickening of the visceral pleura, is capable of only slow expansion, the substitution of oxygen for the fluid will assist this lung to re-expand, and undoubtedly tends to prevent the reaccumulation of the fluid.

FIG. 109.—AUTHOR'S MODIFICATION OF DR. KORNMANN'S APPARATUS FOR INJECTING EITHER NITROGEN OR OXYGEN INTO THE PLEURAL CAVITY.

The principal modifications are: (1) The adjustment of the bulbs which allow 1000 c.c. of gas to be displaced by the weight of the columns of water alone. (2) The needle, which can be used for either nitrogen displacement or oxygen replacement.

Further, in tuberculous pneumothorax the patient often experiences considerable distress from the weight of the fluid. If the effusion is removed by oxygen replacement this distress is prevented, the influence of the oxygen on the reaccumulation of the fluid is again noticeable, and the capacity of the lung to expand can be determined. Garré[5] and Molon[6] have used oxygen with success to alleviate the pain of a dry pleurisy.

OPEN PNEUMOTHORAX AND THE MECHANICAL CONTROL OF IT.

Operative procedures on the organs within the thorax, when they necessitate opening the pleural cavity, are always accompanied with the grave danger of open pneumothorax.

It has been shown by Garré[5] that so long as an opening in the chest-wall which allows of communication between the outer air and the pleural cavity is not larger than the opening of the glottis, the physiological effects on the cardiac and respiratory mechanisms are not serious. In such circumstances, with each inspiration and expiration, less air enters and is driven out of the chest than passes in and

out of the glottis, and the lung collapses gradually. Alterations in the volume of the lung still occur with each respiratory effort, thus helping in the maintenance of the pulmonary circulation and of the aeration of the blood.

When a large opening is made into the pleural cavity there is complete collapse of the lung with total abolition of respiratory variations in size, and a loss therefore of the constant alteration in the pressure ratio of the pulmonary veins and arteries and of the alveoli and alveolar vessels.

The loss also of the difference between intratracheal and intrapleural pressures permits of a dilatation of the alveolar vessels, with the result that the collapsed lung contains more blood than the functioning lung, and is able neither to circulate nor aerate it efficiently.

Another concomitant of a pneumothorax with a large opening is a " to-and-fro flapping " of the mediastinum. With each inspiration the negative pressure in the unaffected half of the chest exerts a traction on the mediastinum and its contents to that side, the diminution of the negative pressure of expiration allows the mediastinum to resume its normal position, while the marked rise of pressure that occurs with forced respiratory efforts, e.g., coughing, drives the mediastinum to the opposite side.

This " to-and-fro flapping " of the mediastinum is thought by Sauerbruch and Garré to be the main factor responsible for the symptoms—cyanosis, dyspnœa, rapid irregular beating of the heart, and later, cardiac and respiratory failure—which appear when the pleural cavity is widely opened.

Within the last ten years these dangers have been greatly minimized by the discovery of means of controlling and compensating for the open pneumothorax.

The idea of preventing lung collapse by producing a differential pressure between the intra-alveolar air and the external air seems to have materialized first in 1895, when Tuffier and Hallion[7] made a primitive apparatus for supplying air at a positive pressure into the trachea. But it was not till 1903 that, at the instigation of Miculicz, Sauerbruch,[8] after much experimental investigation, evolved his hypo-atmospheric (*unterdruch*) and hyperatmospheric (*ueberdruch*) apparatus, but almost immediately gave up the latter in favour of the former. Brauer,[9] working at the same time, devised quite independently the principle of compensating the open pneumothorax by the hyperatmospheric apparatus, which was the first of this type to become generally known.

The essential difference between the hypo- and hyper-atmospheric principles is that in the former the patient's chest is opened in a chamber in which the atmosphere is at a negative pressure of 7 mm. of mercury. In this room are the surgeon and his assistants and all the appurtenances of the operation. The patient's head, however, is outside the room, a close-fitting collar surrounding the neck, so that he breathes air at atmospheric pressure. The anæsthetist is also necessarily outside, but can communicate with the surgeon by telephone. The lower part of the trunk and the lower limbs of the patient, though in the chamber, are enclosed in a rubber sack which is in direct communication with the external air, to exclude this part of the systemic circulation from the influence of the negative pressure.

The hyperatmospheric apparatus, on the other hand, supplies air to the lungs at a positive pressure of from 4 to 8 or more mm. of mercury, while the

surface of the lung when the chest is opened is exposed to a pressure of 0. In the Brauer machine, the air mixed with chloroform is forced by motor or hand-pump into a large casket in which the patient's head is enclosed, and the pressure is regulated by an expiratory valve. Several other forms of hyperatmospheric apparatus have been made, involving the use of motors, as in Brauer's; or of compressed air and oxygen with intervening rubber bag, as in that of Tiegel[10] and Lötsch,[11] or with intervening gasometer and regulation of pressure by a Stott governor, as in the author's[12] (*Fig.* 110). The air is conveyed to the patient by casket (Brauer, Karewski[13]), by mask (Tiegel, Schoemaker), or by intubation tube (author).

The pressure required if air is used mainly, is 7 to 8 mm. of mercury, increasing to 15 mm. of mercury just before the pleural cavity is finally closed. It has been found more satisfactory, however, to use a positive pressure of 4 to 6 mm. of mercury only, giving mostly oxygen with a small admixture of air.

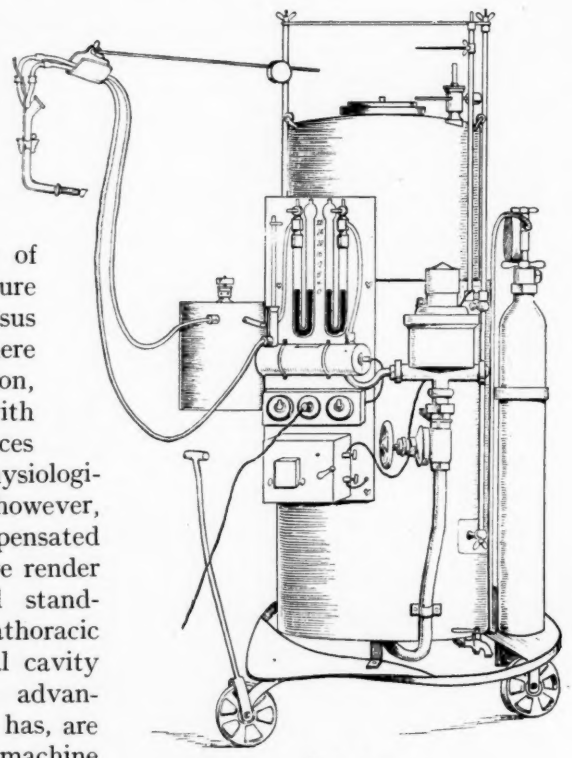


FIG. 110.
AUTHOR'S HYPERATMOSPHERIC APPARATUS.

Many and lengthy arguments, based on extensive experimentation, have been used to uphold the superiority of one form of differential pressure against the other (i.e., hypo- versus hyper-atmospheric system). There is no doubt, in the author's opinion, that the Sauerbruch chamber, with its negative pressure, reproduces much more nearly the normal physiological conditions. Both methods, however, abolish the dangers of the uncompensated pneumothorax, and both therefore render possible (from the physiological standpoint) the performance of intrathoracic operations in which the pleural cavity has to be widely opened. The advantages that the hyperatmospheric has, are the comparative smallness of the machine and its consequent mobility.

Meltzer[14] has introduced another principle, for inflating the lungs and anæsthetizing the patient at the same time. This "insufflation" method is applicable for all operations, and not only for those in which the pleura is opened. The air at a pressure above that of the atmosphere, and mixed with the anæsthetic, is administered by a catheter which passes down the trachea to a point immediately above its bifurcation, while the escaping air passes out between the catheter and the sides of the trachea and glottis.

THE VALUE OF THE VARIOUS METHODS OF ANÆSTHETIZATION FOR OPERATIONS ON THE THORAX.

The administration of a general anæsthetic to a patient, one side of whose chest is full of fluid causing displacement of the mediastinum, or who has an extensive pericaridal effusion, or on whom it is intended to produce partial collapse of a lung filled with septic matter, is such a serious undertaking that a few remarks on the question of the anæsthetic are justified in this article.

The introduction of local, or much more particularly of regional, anæsthetization has done much to aid the surgeon in this field of his work. The opening and draining of an empyema, the removal of ribs for bronchiectasis or chronic empyema, the "Pfeiler-Resektion" of Wilms for tuberculosis, the removal of costal cartilages for bronchitis and emphysema or for the opening of a pericardial effusion, should all be done, whenever possible, under regional or local anæsthesia with novocaine.*

For the more extensive intrathoracic operations, infusion ether anæsthesia offers many advantages, and when using my hyperatmospheric apparatus, I consider this method of anæsthetization preferable to all others. When a general anæsthetic is given other than by the intravenous method, chloroform is the least irritating, and should be used in preference to ether.

The adoption of the principle of "anoci-association" (Crile[15]) is proving of great value in the major operations.

SIMPLE, TUBERCULOUS, AND PYOGENIC EFFUSIONS IN THE PLEURAL CAVITY.

Simple and Tuberculous Effusions.—These have already been discussed under "Oxygen Replacement."

Empyema.—Ever since the time of Hippocrates, thoracotomy, with or without rib resection, has been the surgical procedure for acute empyema. Improvements in technique have possibly been developed since that early date, a knowledge of infection and the means of guarding against it have certainly been acquired, but the mortality is still very high (20 to 30 per cent), and the cases that become chronic with either a fistulous track or cavity are far too numerous (10 to 20 per cent).

In those cases in which, despite adequate drainage, a delay in the obliteration of the empyema occurs, even though the lung is healthy and primary disease of the pleura (e.g., actinomycosis) and rib caries have been excluded, the rigidity of the surrounding wall will be found to be the deterrent cause. The chest wall is capable of a slight degree of collapse, and the diaphragm of a moderate degree of upward displacement only. In the early stages, therefore, the chief hope of obliterating the space lies in the possibility of obtaining expansion of the lung by stretching the thickened visceral pleura.

For this purpose, various forms of apparatus for exerting continuous suction

---

* For details on Regional Anæsthesia, the excellent paper of Dr. Rood in the *B. M. J.*, 1911, may be consulted.

and securing at the same time adequate drainage, have been devised and utilized by many surgeons. Lawrow,[16] in an extensive review of the subject, comes to the conclusion, as a result of his experience and that of others who have employed these means, that " the aspiration method exerts an undoubted influence on the expansion of the lung and the diminution of the size of the cavity. In cases of acute empyema, the expansion of the lung proceeds much more rapidly under the influence of aspiration than by the use of the previous ordinary methods of treatment." Lawrow uses a modification of Nordmann's apparatus.

Chronic Empyema.—In every case of chronic empyema, two operations at least are necessary. The first is directed entirely to securing free drainage of the cavity, exploring its extent, and dealing with foreign bodies or necrosed ribs.

The second and subsequent operations have for their object the freeing of the rigid walls which surround the cavity, by allowing either the chest wall to collapse, or the lung to expand. Three types of operation have been evolved. Originally described and done by Simon, in 1870, but modified and described under the name of thoracoplasty in 1878 by Estlander, the operation which is called after him came into general use. Estlander's operation consists of the partial resection of several ribs. Schede introduced his operation of removal of ribs and thickened parietal pleura in 1890. This method of treatment is severer than Estlander's, but is more suitable for large cavities.

Delorme, appreciating the capacity of a healthy lung to expand if not hemmed in by a dense pleura, advocated and practised with success the stripping of the thickened pleura off the lung surface. To this, thoracoplasty may often with advantage be added.

The author has done Wilms' " Pfeiler Resektion " operation (see p. 252) on a patient suffering from a chronic empyema extending from the 4th space in the mid-axillary line to over the dome of the apex. The operation resulted in a considerable reduction in the size of the cavity.

While the operation of Wilms can be applicable to cases where there is a shallow cavity between the two layers of the pleura only, it suggests the possibility of treating even large empyemata by removing either extremity of the ribs as a first stage, and at a later operation raising a large flap containing the divided ribs from off the thickened pleura, which is then cut away. The advantage of this is that the first stage can be done aseptically, and the second operation exposes a minimum of freshly-divided cellular tissue to the infection. The exposure of a large area of raw surface is an objection to Schede's operation, and is a procedure which not infrequently results in septic intoxication and death.

The treatment of fistulæ by bismuth paste is falling into disuse owing to the number of cases of bismuth poisoning which have been recorded. For radiographic purposes a 20 per cent solution of collargol is quite efficient and is non-toxic.

Calcification of the Pleura.—Fibro-calcareous changes in the pleura are an uncommon sequela of chronic infection.

Tuffier, Jardry and Gy,[17] in an admirable paper on this subject, have shown that as the result of the deposit of calcium salts, particularly in the wall of encysted empyemata, plaques and stalactites of varying size and shape may be formed on the surface of the lung or may even penetrate into that organ. Unless

they give rise to symptoms, the calcareous plates should be left, but if operation is undertaken they must be completely removed, otherwise a chronic sinus will develop.

INJURIES OF THE LUNG.

These occur as the result of :—(1) *Crushes or blows, without fracture, of the skeletal part of the thorax;* (2) *Lacerations associated with, or due to, fracture of ribs and sternum;* (3) *Penetrating wounds (bullet or stab).*

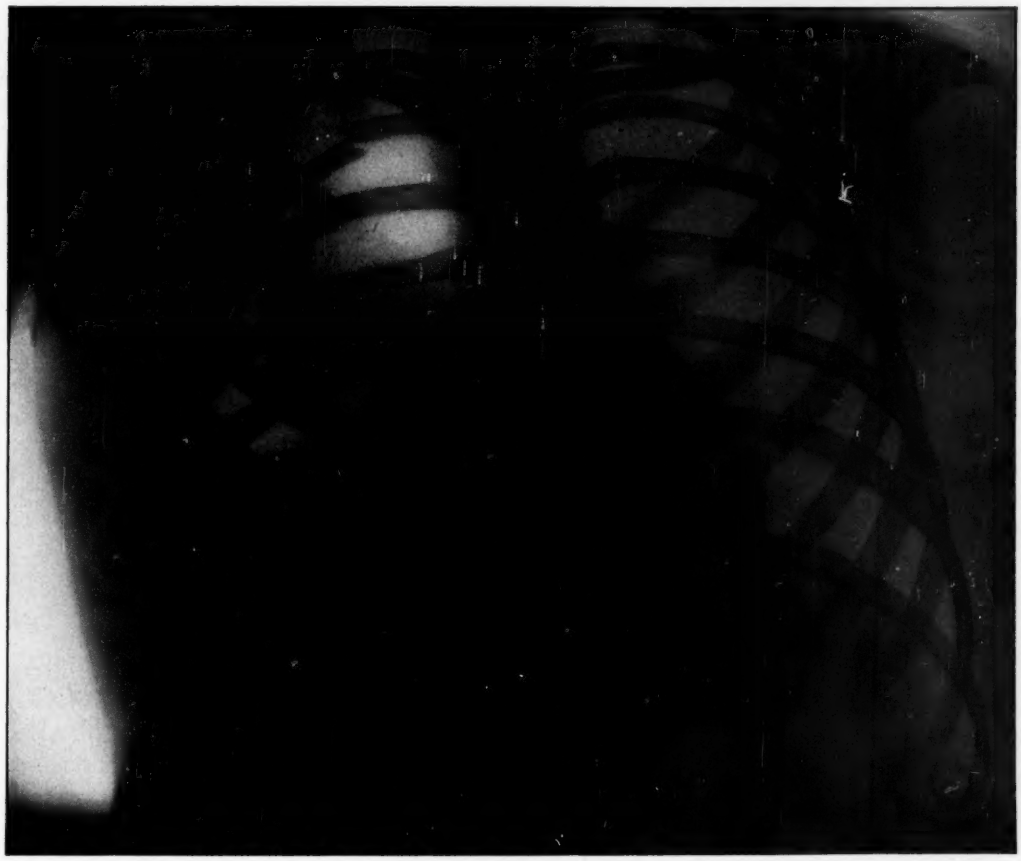


FIG. 111.—A CASE OF HÆMOPNEUMOTHORAX DUE TO FRACTURE OF THE 4TH AND 5TH RIBS ON THE RIGHT SIDE.

The lesion may be of the lung only, or may be complicated by injury of other intrathoracic structures or of intra-abdominal organs. The symptoms of rupture or laceration of the lung are shock, dyspnœa, with shallow respirations mainly abdominal in character, and constant distressing cough. Hæmoptysis, while it is the most certain indication of lung injury, is not always present. In addition to these symptoms are the physical signs of hæmothorax and pneumothorax.

The escape of air from the lungs is probably the most serious of all the

complications of lung injury. When the escape is into the closed pleural cavity only, there is danger of ingravescent pneumothorax, i.e., the condition of steadily increasing pressure of air which at first produces collapse of the lung, then displacement of the mediastinum and contents, and lastly compression of the opposite lung as well, and death.

This condition of ingravescent pneumothorax may be the result of a valve-opening in the lung allowing air to enter the pleural cavity but not to escape from it. Or it may be due to the " Pressatmung " of Sauerbruch,[18] the " grunting " breathing associated with a closure of the glottis, a reflex effect of the pain, the forced expiration raising the intratracheal and intrabronchial pressure, as in coughing and expelling the air through the rent in the lung.

If the pleural cavity in such circumstances communicates with the tissues of the chest wall, surgical emphysema will result, but though this may become very extensive, it is rarely dangerous.

Far graver is the escape of air into the mediastinum, as its presence is not recognizable until it has extended up to the neck, appearing round the trachea. The symptoms of mediastinal emphysema are marked dyspnœa, cyanosis, engorgement of the veins of the neck, progressive cardiac embarrassment, and great distress of the patient.

Nélaton was the first to call attention to an interesting condition—concussion of the chest. In a few cases, a violent blow on the chest has been immediately followed by syncope and death, and the autopsy has revealed no visible lesion. The experimental work of Meola[19] and Reidinger[20] indicates that the cause of this phenomenon is a reflex due to stimulation of the vagus and paralysis of the sympathetic.

Saar[21] has drawn attention to a small but extremely interesting group of cases in which, following on a lesion of the chest wall in such a position that no possible injury to the brachial plexus could have occurred, there has been a total or partial motor, sensory, or sensori-motor paralysis of the arm on the same side. This condition cannot be regarded as hysterical in all cases, but would appear to belong to the group of manifestations known as *pleural reflex.* In experiments on animals, Saar has obtained clonic movements of the fore limb by stimulation of the parietal pleura. A somewhat analogous condition is the muscular atrophy of the arm which has been noticed rarely after a severe hæmoptysis.

It is becoming increasingly obvious that the conservative treatment, when efficiently carried out, offers the greatest possibility of recovery in cases of lung injury, and that operation should be undertaken only when certain well-marked manifestations are present. Tuffier[22] says : " Plus je vois, plus j'ai la conviction que les indications opératives sont particulièrement rares, que la mortalité dans les plaies graves du poumon a lieu dans toutes premières heures après l'accident, et que, cette période passée, la guérison est la règle."

The indications for operation are excellently summarized by Garré[5] when he says : " In cases of lung rupture, as also of stab or bullet wounds, the indications for thoracotomy and suture of the lung are present when the condition is one of severe intrathoracic bleeding which, despite immediate palliative measures and absolute rest, manifests its progressive character by weakening of the respirations and pulse, and increasing cyanosis and anæmia. The same applies

to those cases in which the bleeding, at first arrested, is repeated and threatens life, and to those also with progressive mediastinal emphysema."

During the operation the pneumothorax must be controlled by some form of differential-pressure mechanism. The pleural cavity is emptied of clot, and wounds in the lung are stitched up, preferably with catgut, but extensively damaged portions should be removed.

For closure of the bronchus, Tiegel[23] recommends that the suture should pass through the outer wall only—and not include the cartilage—and that for additional security a portion of the neighbouring lung should be drawn over the wound and fixed in position by the first and last stitches in the bronchus, which are left long for this purpose.

Tiegel[24] has also suggested an ingenious method of relieving the acute symptoms of mediastinal emphysema, and so improving the condition of the patient for the more extensive operation of thoracotomy. An incision is made in the neck above the suprasternal notch, and a Bier's cup connected with a Sprengel's pump applied over this sucks the air out of the chest.

Sauerbruch has operated on patients with mediastinal emphysema in his "unterdruch" chamber, and finds that the negative pressure draws the air out of the mediastinum during the operation.

The statistics collected by Lenormant[25] indicate that drainage after operation for lung injury is inadvisable. Of forty cases which were not drained, 15 per cent developed sepsis, whilst in forty-five cases in which the lung was either sutured or plugged, 42 per cent became infected.

Emphasis must be laid on the necessity for absolute rest in the conservative treatment. *Absolute rest* must be taken in its most literal sense, as the slightest movement may accelerate the hæmorrhage or reopen a closed vessel. Morphia should be given freely to quiet the patient and relieve the discomfort of complete absence of any change in position.

Sauerbruch[26] advocates in cases of combined intrathoracic and intra-abdominal injury, that the chest should be opened along the seventh intercostal space, the pulmonary lesion dealt with, and that the abdomen should then be explored through the same wound, access to the cavity being obtained by cutting through the diaphragm at right angles to the fibres.

Foreign Bodies in the Lower Air-Passages and Lungs.—The great advances that have occurred in the removal of foreign bodies from the air-passages and the lungs are due to the accurate localization rendered possible by the *x*-rays, to the invention of Killian, to the perfection of the apparatus by Brüning for exploring the trachea and bronchi and carrying out manipulations in the depths of the air-passages, and to a less extent to the improvement in the technique of pneumotomy.

In 1897, the year that Killian published his first record of the successful use of the bronchoscope, Tuffier published the results of eleven cases of pneumotomy for the removal of foreign bodies. In ten of these the search was futile, and four of the patients died. Ten years later Killian[27] was able to report the treatment of 159 cases with a mortality of only 13 per cent. The removal of the foreign body was successfully accomplished from the upper air-passages in fifty-four cases, and from the lower in sixty-three.

The bronchoscope may fail on account of secondary changes in the bronchus and adjacent lung tissue, or because of the depths to which the foreign body has been inhaled, and operation must then be resorted to.

The extrapleural part of the bronchus can be reached through a posterior wound, the lung and pleura being displaced outwards. When, however, the seat of the trouble is in the lung substance itself, pneumotomy by the trans-pleural route (and the use of some form of differential-pressure apparatus) must be essayed. The added danger of pleural infection in such cases is very great.

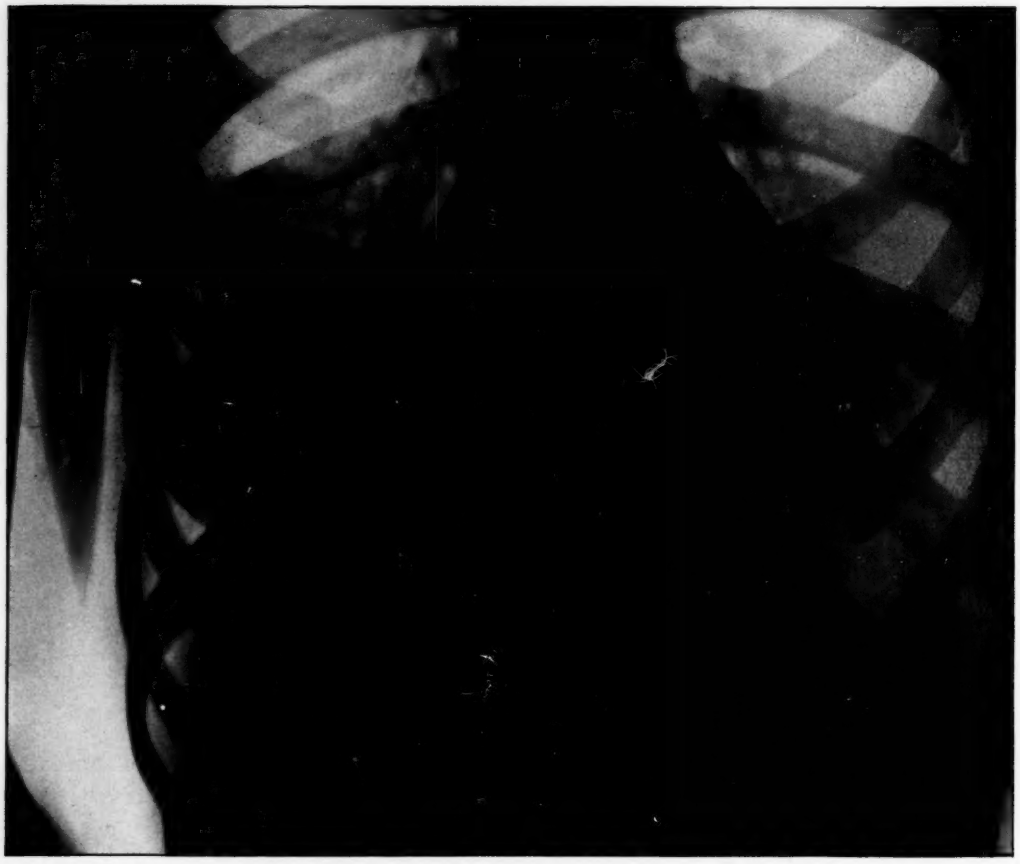


FIG. 112.—GANGRENE OF THE RIGHT MIDDLE LOBE.
In this case there were no adhesions of the pleural membranes.

ACUTE ABSCESS AND GANGRENE.

The separation of the acute infective processes of the lung into simple abscess, putrid abscess, and gangrene, is an unnecessary complication in nomenclature. The differentiation between the last two is by no means clear either clinically or pathologically. Gangrene is distinguished from abscess by the stinking character of the pus, the odour of which contaminates the breath; the

ragged ill-defined gangrenous walls of the cavity; and often by the presence of sloughs. The course of a gangrenous focus, moreover, is almost always a steadily progressive one, and spontaneous healing by rupture into a bronchus is a very rare occurrence. In the case of simple abscess, on the other hand, the condition may be progressive, it may even become gangrenous, or it may subside into a chronic condition. Spontaneous cure is somewhat more frequent than with the gangrenous variety.

As far as the treatment is concerned, the operative procedure in the two varieties is practically identical, apart from the fact that in the case of simple abscess it may be justifiable to delay for a few days in the hope that spontaneous healing will occur, bearing in mind however the dangers should the condition become chronic.

The necessity for immediate active treatment is evident from a comparison of statistics which show that cases of abscess and gangrene treated without operation have the appalling mortality of 80 per cent, while the mortality after pneumotomy varies from 34·5 per cent (Lenhartz[28]) to 17·5 per cent (Garré and Quincke,[5] 1912). The diminution in the death-rate within recent years is strikingly shown by Garré, who has collected the results of all published cases. In the 1903 edition of the *Grundriss der Lungenchirurgie*, the mortality in 400 cases was 25 per cent. Between that time and the second edition (under the title *Lungenchirurgie*) in 1912, a further 182 cases of gangrene and abscess have been collected, with a mortality of 17·5 per cent only.

This marked improvement in the results obtained by surgical interference in these acute suppurative conditions can undoubtedly be attributed to the increased facility for localization afforded by the progress of radiology, and to the diminution in the danger of opening the chest, in the absence of adequate adhesions, by the use of a differential-pressure apparatus.

The following points must be considered in regard to the operation :—(1) *The method of access;* (2) *The problem of adhesions;* (3) *The discovery of the abscess;* (4) *The treatment of the cavity;* (5) *The question of secondary abscesses;* (6) *The complication of empyema;* (7) *Secondary hæmorrhage;* (8) *After-treatment.*

1. The route of approach is determined by the position of the cavity as ascertained by clinical and radiological examination. The pleura should be exposed over a wide area to permit satisfactory exploration of the lung. The displacement of a flap is the best means of accomplishing this, and the ribs underlying the flap should be removed, so that by rendering the chest wall more yielding, the shrinkage of the cavity is facilitated.

2. When the parietal pleura is thin, the lung can be seen through it, and its movements studied. If these are evident it is certain that adhesions, if present, are not sufficiently firm to prevent a pneumothorax occurring. When the parietal pleura is thickened, however, the existence of adhesions cannot be determined. Firm adherence of the two pleural surfaces is found in 50 per cent of the cases only. The advantages of being able to compensate the possible pneumothorax by a hyper- or hypo-atmospheric apparatus are obvious. If the pleural membranes are free, the lung can be explored through an incision in the parietal pleura, and the affected area brought up to the chest wall and stitched to the parietal pleura. When no such apparatus is available the two surfaces of the pleura must be made to unite by stitching the parietal to the visceral layer

(including a portion of lung in each stitch) around the circumference of the exposed part, when the second stage may be proceeded with immediately or deferred for a few days. A delay is obviously very serious when acute gangrene is the lesion, but is less so in cases of simple abscess.

In the more chronic cases, Perthes[29] urges that the operation should always be done in two stages :—(1) Resection of ribs and suture of pleura, the cavity having previously been emptied by coughing and inversion, and the patient being anæsthetized with chloroform ; (2) Cavity full, no anæsthetic other than morphia. Opening of cavity, and drainage.

The majority of Lenhartz's cases were done in two stages. Körte,[30] Garré, and Tuffier, on the other hand, prefer to complete the operation at once.

3. The discovery of the abscess, unless the lung has been palpated, is often difficult. Tuffier's method of extrapleural palpation is not to be recommended.

Exploration with needle and syringe is justified only after the pleural surfaces have been united. If pus is found, an incision is made along the needle which has been left *in situ*. When pus is not found by the exploring needle, a gradually deepening crucial incision should be made, the vessels being ligatured as soon as cut ; great caution is necessary as the root of the lung is approached. If, even by this means, the abscess is not discovered, the wound should be packed in the hope that the abscess will burst into it.

4. The cavity found, it must be fully explored, and the pus and sequestra removed. The edges are stitched back so as to ensure free drainage, and the whole opening is plugged with gauze.

5. Secondary cavities may be known to exist, and their position ascertained by radiology. In such cases they may be looked for, but an extensive search is not justified.

6. When pus in the pleura complicates abscess, the prognosis is very grave. The empyema should be opened and drained as a preliminary to the search for the pulmonary abscess.

7. The possibility of secondary hæmorrhage must always be realized. Should it occur, the only possible treatment is tight packing of the cavity and the administration of morphia.

8. The special points which must be considered in the after-treatment, are the development of secondary abscess cavities and the inability of the cavity in the lung to close owing to the rigidity of the chest-wall. If the rib resection done at the first operation is not sufficient, together with the cicatrization of the tissues round the abscess, to allow of complete obliteration of the cavity, the chest wall must be rendered more mobile by the removal of further portions of ribs.

Tuffier[31] has in two cases attempted an extrapleural collapse of the lung by displacing the parietal pleura off the chest wall and implanting in one case a lipoma and in the other a large piece of omentum. The result in the former case, when seen two years later, was most satisfactory.

Methods of Producing Solidification of the Lung.—As will be seen in the two ensuing sections, solidification of the lung is the basis of the surgical treatment of bronchiectasis and tuberculosis.

The many methods which have been suggested and practised for effecting this purpose may be divided into two classes :—

1. That directed towards producing temporary collapse of the lung—nitrogen displacement.

2. Those directed towards producing permanent consolidation :—

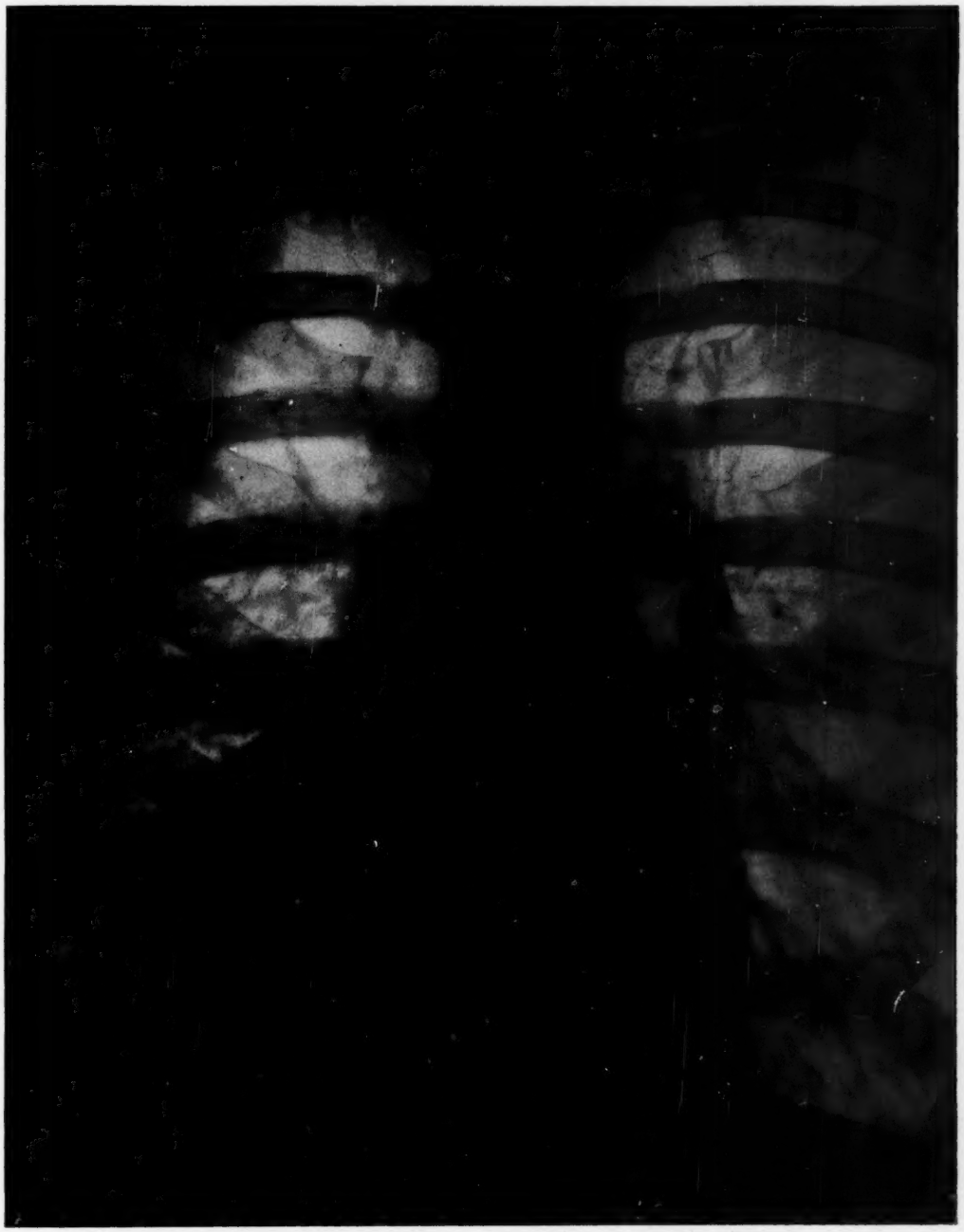


FIG. 113.—BRONCHIECTASIS OF THE RIGHT LOWER LOBE.

a. Of part of the lung: Rib resection; Division of the phrenic nerve; Ligature of the pulmonary artery.

b. Of the whole lung: Rib resection; Rib mobilization.

Bronchiectasis.—Numerous classifications of bronchiectasis have been made, but from the surgeon's point of view three types only need be considered:

1. In which the main lesion is an abscess cavity.

2. The multilobular type, in which the whole of the lung is affected while the opposite side is partially involved or quite free from disease. Fibrosis is a marked feature of this variety, and the associated cicatrization produces excessive displacement of the heart and mediastinum to that side, with upward traction of the diaphragm and shrinkage of the chest wall.

3. A general cylindrical enlargement of the bronchi of one lobe, usually the lower, and no other change except possibly slight general bronchitis (*Fig.* 113).

The treatment of the first group of conditions is the same as that for chronic abscess cavities, viz., pneumotomy and drainage.

While it is but rarely that either of the other two varieties can be completely cured, it is not so difficult to produce a very considerable improvement in the patient's condition, and to lessen greatly the cough and sputum. Certainly it may be said that the results of surgical treatment of bronchiectasis are very much more encouraging than those obtained by medical treatment. As in chronic suppurative conditions of bones, however, the treatment is often of long duration, and necessitates at times repeated operations.

The difficulties in the treatment are well shown by the various methods which are being tried: nitrogen pneumothorax, thoracoplasty with preliminary pneumothorax, thoracoplasty with displacement of the affected lobe, amputation of the affected lobe, ligature of the branch of the pulmonary artery supplying the bronchiectatic area.

The results obtained by pneumothorax alone are discouraging. The symptoms are improved so long only as the lung is in a state of collapse; as soon as re-expansion occurs there is a recrudescence of the disease.

Thoracoplasty, to both a limited and an extensive degree, has been frequently tried, and with some measure of success. The mortality of extensive rib resection is high and the cures are few.

The author advocates collapse of the lung when possible by nitrogen displacement, so as to improve the general condition of the patient and lessen the sputum and cough, as a preliminary measure to rib resection. He has also tried, in a child with extensive but mainly unilateral bronchiectasis, the rib mobilization operation as done by Wilms for phthisis. The extremely satisfactory collapse of the lung and chest wall is seen in *Fig.* 114. The patient, who previously was expectorating several ounces of sputum per diem, brought up, twelve days after the operation (when the skiagram was taken), 1 dr. only.

Garré, in one case, after removing three ribs, displaced the lower lobe upwards and invaginated it, in an endeavour to promote atelectasis. The involvement of the opposite side, however, interfered with success.

Körte, Garré, Krause, Lenhartz, Kummell, and Heidenhaim, have all successfully amputated a bronchiectatic lobe.

The most recent suggestion in the treatment of this chronic disease comes from Sauerbruch and Bruns.[32] As the result of experimental investigations, they find that when a branch of the pulmonary artery is ligatured, the lobe supplied undergoes "a process of cicatrization and shrinkage by which the parenchyma is transformed into a thick firm scar. At the same time a chronic inflammatory process of the pleura develops, which leads to thickening and fixation of the surface of the pleura to the chest wall." The operation is done

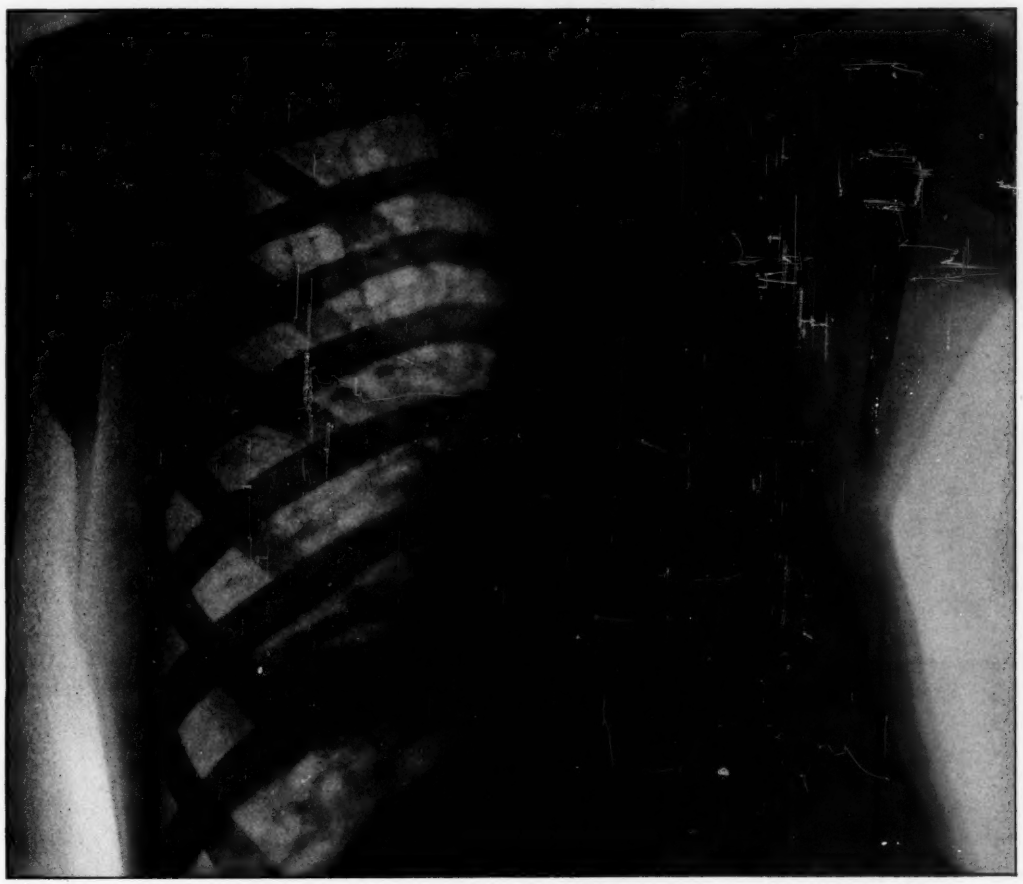


FIG. 114.—SKIAGRAM TAKEN TWELVE DAYS AFTER RIB MOBILIZATION FOR COMPLETE LEFT-SIDED BRONCHIECTASIS.

through an incision in the side of the chest along the fifth intercostal space. The upper and lower lobes are carefully separated from each other, any adhesions being cautiously divided. On reaching the hilum, the artery is recognized by its anatomical position, and ligatured. The wound is then closed. A hypo- or hyper-atmospheric apparatus must be used.

The second stage of the operation, the resection of the ribs overlying the lobe, is done some weeks later.

Sauerbruch[26] has done this operation seven times with most encouraging

results. He states, however, that Jehn has shown that in very chronic cases the rigidity of the widely-dilated bronchi may prevent the complete consolidation of the lung; Sauerbruch urges therefore the advisability of operating while these structures are still soft and pliable.

The author has ligatured the branch of the pulmonary artery in one case of unilobar bronchiectasis. Although gangrene of the lobe and a localized empyema developed after the operation, the subsequent effect has been most satisfactory. The patient now, two months after the operation, is apparently cured of his bronchiectasis, while the sinus through which the empyema was drained is rapidly closing.

Tuberculosis.—Of the many advances which have been made by the surgical treatment of pulmonary diseases, none are more gratifying than those obtained in phthisis. The resistance of the disease to the ordinary methods of treatment has resulted, in the great majority of cases, despite the frequency with which temporary improvement is seen, in a small percentage only of cures. The introduction, however, of measures by which the lung can be put into a condition of complete temporary or permanent collapse has very greatly improved the prognosis of all cases, at any rate, in which one lung is not extensively involved.

The importance of radiological examination before any such surgical step is taken cannot be too strongly emphasized, as, however thorough the clinical examination may be, it is impossible to be certain that either the extent of the disease is ascertained or the primary seat of the lesion is realized until such investigation has been made.

The great value of nitrogen displacement and the technique of the procedure have already been discussed in an earlier section. It was pointed out also that when the pleural surfaces were adherent, the collapse of the lung by this method was impracticable. In such circumstances collapse has been obtained by removing the ribs from over the affected part of the thorax, and allowing the lung and decostalized chest wall to sink in *en masse*. In the hands of certain surgeons this treatment has met with a measure of success, but it has the great disadvantage of necessitating a very big operation, or if done in stages, a series of smaller operations, on a patient already exhausted by disease. Friedrich[33] gives statistics of twenty-nine operations on twenty-seven patients with a mortality of 29·6 per cent.

In two of the fifty-eight cases of extrapleural thoracoplasty operated on by Sauerbruch,[34] the lower lobe, unaffected before the operation, became extensively involved owing to aspiration of the secretion squeezed out of the lower lobe, and both cases died.

To obviate the recurrence of such a catastrophe, Sauerbruch has tried in five cases, with considerable success, the effect of dividing the phrenic nerve in the neck. The result of this is to bring the diaphragm into the position of extreme expiration, which tends to collapse the lower lobe at the same time as it abolishes the inspiratory expansion of that part. A further change which is found to take place is a connective-tissue proliferation in the compressed tissues of the lung. Sauerbruch also recommends this operation in cases of bronchiectasis or tubercle of the lower lobe or of chronic empyema, combined in each case with thoracoplasty.

In one case in which the author divided the phrenic nerve, the paralysis of the diaphragm on that side was incomplete. This was probably due to the phrenic receiving a considerable accession of fibres below the point of section, from the nerve to the subclavius.

FIG. 115.—PHTHISIS. PARTIAL PNEUMOTHORAX.
Note the adhesions stretching from the diaphragm to the lung.

There are a few instances of extirpation of a lobe or even of a whole lung. Macewen[35] removed one lung of a patient with advanced phthisis; this man was alive and healthy more than eighteen years later.

Wilms,[36] in 1911, introduced the operation of rib mobilization (" Pfeiler Resektion ") for cases of pulmonary tuberculosis in which intrapleural collapse of the lung was impossible. The principle of the operation is the removal of portions (2 to 3 cm.) of the posterior ends of the upper seven or nine ribs and of the costal cartilages of the first five or six ribs, the essential feature being the mobilization of the first rib; unless this is done, the rest of the operation is valueless. The difficulty is the treatment of the first rib, owing to the horizontal position of the posterior part and the proximity of the first dorsal nerve, and the overlying of the clavicle at the anterior end and the nearness of the subclavian vessels. Access is obtained by a long vertical incision front and back. A period of two to eight weeks should be allowed to elapse after removing the posterior portions before dealing with the anterior. Both operations are done, whenever possible, under local or regional anæsthesia with morphia.

The effect of this mobilization is that the ribs become approximated to the middle line, they tilt down (bucket-handle action), and the whole rib drops so that the divided ends lie at a level of one or two vertebræ lower than previously. The result is a remarkable collapse of the whole side of the chest. and necessarily, therefore, of the lung (*see Fig.* 114). The obliteration of cavities even the size of a walnut occurs.

One other suggestion for the treatment of apical tuberculosis must be mentioned. Freund[37, 38] regards the ossification which takes place in the first costal cartilage as a primary factor in determining the onset of tubercle in the apices of the lung, and asserts that when movement of the upper thoracic opening is re-established by fracture of the ossified cartilage, the apical tubercle heals. Freund recommends, therefore, the division of this cartilage when ossification of it is found in association with apical phthisis. The author,[39] however, has shown (in his article in the first number of this JOURNAL) that apical tuberculosis does not bear any direct relation to the presence of ossification in the first costal cartilage, and that the changes in the cartilages are a normal process progressing with the age of the patient, but occurring earlier and developing to a greater extent in men than in women.

Radiology has also made it abundantly clear that phthisis begins usually as a peribronchial condition, and probably the reason why clinically the signs point to the apex is that the thickening round the bronchus causes an obstruction to the air entry which affects, therefore, the aeration of the distal parts of the lobe, the signs being best heard where the lung is nearest the surface, viz., the apex.

Syphilis and Streptotrichosis.—The progress in our knowledge of the diagnosis and treatment of these two diseases has not been so great as in the conditions previously dealt with, yet there are certain points to which attention must be called.

Both these granulomata present a clinical picture which is frequently confounded with tubercle; but in syphilis, when fully developed, it is characteristic. My attention was first directed to this by Dr. Etlinger.

The striking feature in a typical case is the paucity of physical signs despite

the extent of the symptoms and of the constitutional disturbance. The patient becomes weak and emaciated, has an incessant irritating cough, and constantly brings up small quantities of thin muco-purulent sputum, frequently streaked with blood. The temperature is markedly irregular, and may rise several degrees.

The signs are generally found over the upper part of the lower lobe, where there is an area of dullness most marked in the centre, weakness of breath-sounds corresponding to the alteration of resonance, and fine crepitations best heard over the periphery of the affected regions. The picture, in short, so far as the symptoms are concerned, is that of a very advanced degree of pulmonary tuberculosis, while the physical signs are suggestive of an early lesion.

In the *Bull. et Mém. de la Soc. Méd. des Hôpitaux de Paris*, for January 30th, 1913, there is a detailed description by Bensaude and Emery of such a case, with skiagrams.

Since the work done by Foulerton[40] on the streptothrices, we have to recognize the analogy of a streptothrix infection to tubercle bacteriologically as well as clinically. Actinomycosis is but one of the streptothrices, and therefore need not be considered separately.

These fungi are capable of producing two types of lesion :—

1. The acute miliary form.
2. A local induration with pus formation.

It is the latter type which concerns us here, because it can, in its earlier stages, be treated by surgical measures.

Karewski[41] divides the progress of the disease into three stages. In the first, the infection is localized to the lung itself. In the second, it spreads to and invades the pleura. In the third, the chest wall is attacked and the granuloma, breaking down, discharges externally.

Energetic treatment, viz., the excision of diseased portions of the lung and pleura and the scraping of sinuses, combined with the internal administration of iodides in massive doses, has produced a cure in a number of cases.

Penny[42] records four cases of pulmonary streptotrichosis treated with the most satisfactory results. The treatment consisted of operative intervention and the administration of potassium iodides in two cases, operative and vaccine treatment in one case, vaccine inoculation and potassium iodides in one case.

Primary Malignant Tumours of the Lung and Pleura.—It is a well-known fact that secondary tumours of the lung frequently produce symptoms long before physical signs. Although the same statement is true of primary growths, the importance of this seems not to be appreciated. Since in the earlier stages of some forms of pulmonary neoplasm, the growth can be entirely removed by operation, the paramount necessity of radiography in all cases with symptoms indicative or suggestive of a pulmonary lesion must once more be emphasized.

The author's case is a good instance of the value of this method of examination. The patient, a man aged 44, was sent to him as a case of bronchitis and emphysema, and as such possibly suitable for Freund's operation. He had suffered with chronic cough for many years. His bronchitis had been worse during the winter, and he had had some pain in the right side of the chest for four months. The patient had not got a rigid dilated thorax, but was radiologically examined as part of the routine investigation, and the tumour shown

in *Fig.* 116 was found. Although repeatedly examined by various experts, no physical signs other than those of bronchitis and emphysema could be discovered till three weeks later. A week after the radiological examination the patient brought up "prune-juice" sputum, and numerous large spherical cells with club- or tail-like projections, considered by Adler to be pathognomonic, were found in the expectoration.

The patient refused operation for two months. When operated on, the tumour was found to be confined to the lower lobe, except at one point where the

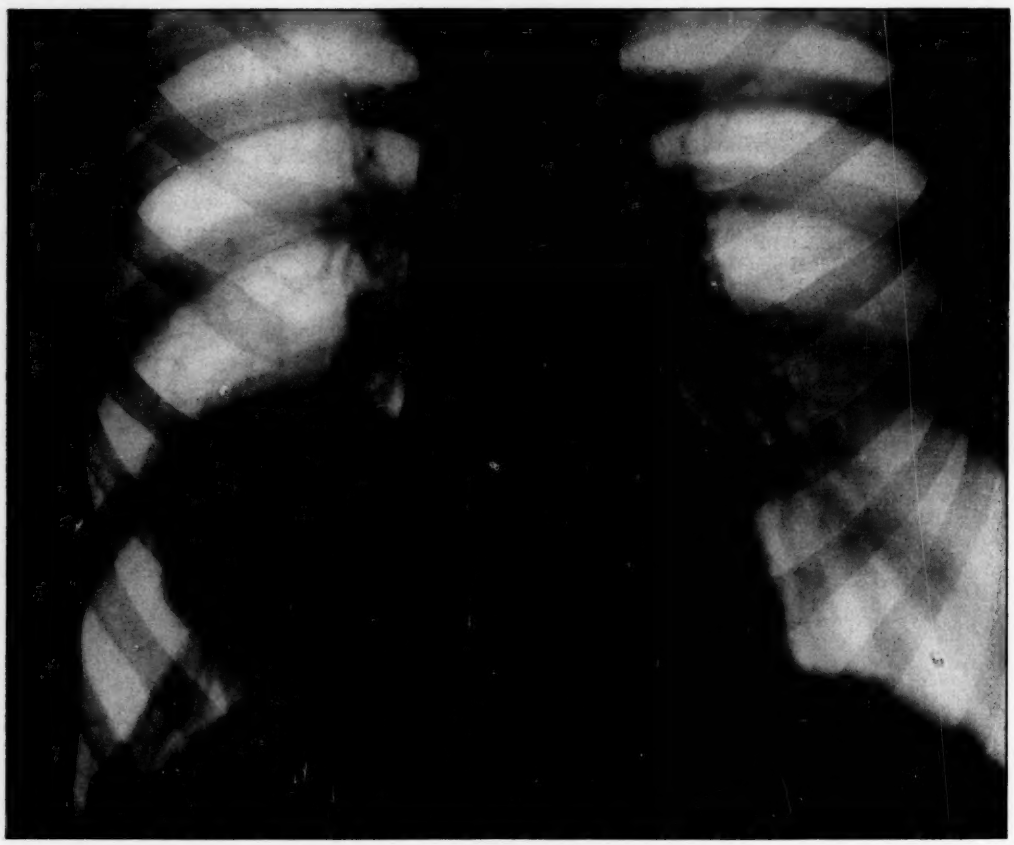


FIG. 116.—PRIMARY BRONCHIAL CARCINOMA.

pleura was adherent. Access was obtained by slitting through the length of the sixth intercostal space (the patient being anæsthetized by infusion ether and the open pneumothorax compensated by the author's hyperatmospheric apparatus). The various structures at the pedicle of the lower lobe were ligated separately, and the lobe containing the growth, together with a portion of the parietal pleura, was removed (*Fig.* 117). The proximal end of the bronchus was stitched over and covered with an adjacent portion of lung. The patient's condition was quite good for the first six days; he then developed an empyema, and died on the eighth day. At the autopsy no evidence of leakage

FIG. 117.—PRIMARY BRONCHIAL CARCINOMA.
Half of the excised lower lobe and tumour.

from the bronchus could be obtained. Microscopic examination of sections from the hilum and adjacent glands failed to show any spread of the cancer from the primary focus. The tumour was a squamous-celled carcinoma of bronchial origin, and had broken down in the centre.

The author has found that in animals, the shock of handling the lung can be abolished by intrathoracic injection of the vagus with novocaine. The vagus was treated in this way in the case just described, and the patient experienced practically no shock after the operation.

Adler, in his admirable monograph on *Primary Malignant Growths of the Lungs and Bronchi*, 1912, has given a full description of the macroscopic and microscopic varieties of pulmonary carcinomata. He confirms the existence of primary neoplasms originating in the lung substance as distinct from the hilum, and concludes that " a cancer of the lung is, taken strictly, a bronchial carcinoma ; that, on the other hand, a carcinoma starting from lung tissue itself occurs, but is extremely rare, and is built up, not of flat but of cylindrical epithelium." The cylindrical carcinomata develop from the bronchial mucous glands, but when the growth originates in the surface epithelium it has an " alveolar structure with polymorphous and polyhedric cells that are, in the great majority of cases, flat."

Adler describes also various macroscopic types of carcinoma. They are : (1) Miliary carcinoma. Probably always secondary ; (2) Nodular forms with metastases scattered through the lung ; (3) Infiltrating type. This forms, " besides extensive pulmonary infiltrations, considerable masses of tumour at the root," leading to pressure and other changes in the lung ; (4) Localized infiltrating type. The tumour affects a portion of the lobe only, and " is sharply defined against the normal lung tissue, and is so dense that within the region of the tumour scarcely any lung tissue can be found." (See author's case.) Any of these tumours may undergo degeneration.

Sarcoma is less common, and tends to form large infiltrating tumours, invading, displacing, and obstructing the neighbouring structures. They are more often of the round-celled, but may be of the spindle-celled variety. Melanotic sarcoma is excessivly rare.

Clinically, pulmonary neoplasms present themselves as : (1) An acute pulmonary lesion resembling acute miliary tuberculosis ; (2) A pleuro-pulmonary lesion, with or without effusion ; (3) A mediastinal tumour ; (4) A broncho-pulmonary lesion.

Cancer of the lung is in some of its varieties, and in its earlier stages, now accessible to surgical intervention and complete removal ; but until this fact is more fully recognized and all pulmonary cases are subjected to routine radiological examination, the growths will not be recognized until they have extended beyond the possibility of all treatment. In all doubtful cases, at least an exploratory thoracotomy should be undertaken.

Pleural tumours include simple and malignant varieties, and of the latter, the most interesting probably are the endotheliomata, which, as they increase in size, show a special tendency to invade the chest wall.[43]

The chief symptoms produced by pleural neoplasms are cough, pleurisy (dry or with effusion), and changes in the lung from pressure on the bronchus.

The endotheliomata in their earlier stages, and the myxo- and fibro-sarcomata, are accessible to surgical intervention.

Bronchitis and Emphysema.—Over fifty years ago, Freund[44, 45] drew attention to the fact that certain cases of bronchitis and emphysema were associated with a rigid and dilated thorax, and suggested that in these the changes in the chest wall were primary, and due to ossification in the costal cartilages, and that bronchitis and emphysema developed as a complication.

While the author agrees with Freund on the correlation of the pulmonary lesion with the fixation of the thorax in the position of extreme inspiration, he does not think that this is necessarily dependent on costal-cartilage ossification. This combination of pathological processes undoubtedly exists without the presence of any ossification in the cartilage, and benefits equally with the type described by Freund, from the operation of chondrectomy.

The operation consists in the removal of the second, third, fourth, and fifth costal cartilages on the right side through a vertical incision. Care must be taken not to perforate the pleura, which is of extreme thinness. Immediately after the cartilages have been cut away, the ribs are seen to approximate to the sternum and to move to and fro with respiration. The resection is done under regional anæsthesia.

The effects of the operation, in the author's experience, are immediate and startling. The dyspnœa and cyanosis disappear, and the patient is freed of the feeling of constriction in the chest, and can undergo exertions which previously were quite impossible.

The first twenty-four hours after the operation is a period of some anxiety, as the patient may refuse to cough owing to the pain, and the accumulation of secretion in the bronchial tubes may result in the development of broncho-pneumonia. The author has found, however, that in those cases in which the cough is inhibited, the anæsthetization of the intercostal nerves with novocaine at once abolishes the pain, and the patient brings up the sputum without difficulty.

Freund recommends that, in advanced cases, the left side be similarly dealt with at a later period.

REFERENCES.

[1] Murphy, *Jour. Amer. Med. Assoc.*, 1898.
[2] Morriston Davies, *Lancet*, Dec. 1912.
[3] Brauer, *Beitr. z. klinik d. Tuberkulose*, 1909.
[4] Forlanini, *Deutsch. Med. Woch.*, 1911.
[5] Garrè und Quincke, Lungen Chirurgie. Jena, 1912.
[6] Molon, XIX Congresso di Medic. interna. ed all'Ordino del Sanitari di Venezia, 1909.
[7] Tuffier et Hallion, *Soc. de Biologie*, 1896.
[8] Sauerbruch, *Verhandl. d. Deutsch. Gesell. f. Chir.* 1904.
[9] Brauer, *Ibid.*
[10] Tiegel, *Beitr. z. klin. Chir.*, Bd. 64, 1909.
[11] Lötsch, *Archiv. für klin. Chir.*, Bd. 93.
[12] Morriston Davies, *Brit. Med. Jour.*, July, 1911.
[13] Karewski, *Berl. klin. Woch.*, 1909.
[14] Meltzer, *Jour. Amer. Med. Assoc.*, 1911.
[15] Crile, *Lancet*, 1913.
[16] Lawrow, *Bruns. Beitr. z. klin. Chir.*, Bd. 83, 1913.

[17] TUFFIER, JARDRY ET GY, *Revue de Chir.*, 1903.
[18] SAUERBRUCH, *Beitr. z. klin. Chir.*, Bd. 60, 1908.
[19] MEOLA, *Giorn. Internaz. d. Soc. Med.*, 1879.
[20] REIDINGER, *Festschrift. der Alma Julia Maximiliana*, Würzburg, 1882.
[21] SAAR, *Verhandl. d. Deutsch. Gesell.*, 1912.
[22] TUFFIER, *Soc. de Chir.*, 1911.
[23] TIEGEL, *Beitr. z. klin. Chir.*, Bd., 66, 1910.
[24] TIEGEL, *Zentralbl. f. Chir.*, No. 12, 1911.
[25] LENORMANT, *III Congr. d. l. Soc. Intern. d. Chir.*, 1911.
[26] SAUERBRUCH, *XVII Intern. Cong. of Med.*, 1913.
[27] KILLIAN, *Zeitsch. f. Ohrenheilkunde*, Bd. 55, 1908.
[28] KISSLING, *Mitth. a. d. Hamburg. Staatskranken*, Bd. 6, 1906.
[29] PERTHES, *Verhandl. d. Deutsch. Gesell.*, 1908.
[30] FRAENKEL UND KÖRTE, *Berl. Med. Gesell.*, 1912.
[31] TUFFIER, *Soc. de Chir.*, 1910.
[32] SAUERBRUCH, Technik der Thoraxchirurgie. Berlin, 1911.
[33] FRIEDRICH, *III Congr. d. l. Soc. Intern. de Chir.*, 1911.
[34] SAUERBRUCH, *Münch. Med. Woch.*, Bd. 60, 1913.
[35] MACEWEN, *XVII Intern. Congr. de Med.*, 1913.
[36] WILMS, *Die Therapie der Gegenwart.*, Bd. 54, 1913.
[37] FREUND, *Münch. Med. Wocl.*, 1907.
[38] FREUND, *Verhandl. d. Deutsch. Gesell. f. Chir.*, 1910.
[39] MORRISTON DAVIES, *Brit. Jour. of Surg.*, 1913, No. 1.
[40] FOULERTON, The Streptotrichoses and Tuberculosis. London, 1910.
[41] KAREWSKI, *Verhandl. d. Deutsch. Gesell. f. Chir.*, 1907.
[42] PENNY, *Middlesex Hosp. Jour.*, 1912.
[43] MORRISTON DAVIES, *Clin. Jour.*, 1912.
[44] FREUND, *Breslau*, 1858.
[45] FREUND, *Erlangen*, 1859.

THE ANATOMY AND TREATMENT OF CLEFT PALATE.

By FRANCIS W. GOYDER, Bradford.

The following paper, condensed from my Jacksonian Essay on the Embryology and Treatment of Cleft Palate, is published by the kind permission of the Council of the Royal College of Surgeons of England. If some of the conclusions seem to be insufficiently supported by the evidence produced, it is due chiefly to the necessary elimination of much of the matter.

The essay is an attempt to arrive at the best method of operating in cleft palate, and the proper time for performing the operation. The conclusions reached have been based, first, upon the consideration of the anatomical peculiarities of the cleft palate; next, on the mechanical possibilities of certain operations in their relation to the production of an anatomically perfect result. The essential factors for normal speech are enquired into, and certain criteria of a successful result laid down. An attempt is made to discover from the examination of published results, and from the author's own cases, how far these results satisfy the conditions considered essential, and at what period of life the best results are attained. Certain final conclusions are then drawn, from which it has been the author's main effort to eliminate personal bias and prejudice. These conclusions, he believes, may be taken as good working rules, in the present state of our knowledge, for the guidance of those who approach the subject for the first time and are anxious to do the best for their patients.

Space does not permit of a description of the embryology of the deformity. A concise account is given in Berry and Legg's book.[1] The recent work of J. Ernest Fraser[2, 3] and others, has added a good deal to our knowledge of the subject. It is more important for our present purpose to consider pre- and post-natal anatomy; for upon this most of our conclusions regarding surgery are based.

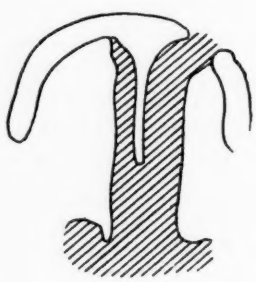
Varieties of Cleft Palate.—Whatever their exact method of formation, in the normal development of the palate we get ultimately three main masses—a median, and two lateral maxillary elements. Partial or complete failure of union along these lines of natural junction results in cleft palate, and almost every possible variation has been observed. Where the three segments are separate, we have the tripartite palate; where two are fused, the median and one of the lateral segments, we get the bipartite type. The remaining varieties are incomplete clefts. It is obvious from the mode of development that a cleft through the alveolus cannot, except in the very rare event of an absent premaxilla, be median. The greater frequency of posterior clefts is easily accounted for, since normal union of the palate begins in front and extends backwards. It is an almost universal rule, therefore, that a cleft alveolus or a cleft hard palate is accompanied by a complete cleft in the soft palate; so that of the common types of cleft we get all varieties, from the simple bifid uvula to clefts involving the whole soft palate, the whole soft palate and part of the hard, and finally

the whole of the soft and hard on one or both sides of the premaxilla. Great variations occur also in the width of the cleft, the abruptness of the separation of its margins at its anterior end, and the height and slope of the segments of the hard palate. The practical importance of these will appear later. The frequency of the various types, calculated from 649 cases described by Keith,[4] Haug,[5] Berry,[6] Legg,[7] Ulrich,[8] and by me, is as follows :—

Tripartite palate	22·8 %
Bipartite palate	31·9 %
Cleft of the soft and part of the hard palate	28·7 %
Cleft of the soft palate only	15·7 %
All other varieties	0·9 %

Illustrations of the Various Types of Cleft.—

1. *Tripartite Cleft.—Cases* 25 (*Fig.* 127), 29 (*Fig.* 139), and 36 (*Fig.* 151) show this form very well. Notice the irregular growth and overgrowth of the septum ; how the premaxillary segment is tilted in all three ; the oblique and twisted and very greatly lengthened septum.



FIGS. 118, 119.—*Case* 15. Age 9 months. Bipartite, almost tripartite palate, but incomplete harelip : hence no premaxillary projection.

2. *Bipartite Palate.*—Examples illustrated are *Cases* 15 (*Fig.* 118), 17, 23 (*Fig.* 120), 24 (*Fig.* 122), 26 (*Fig.* 131), 27 (*Fig.* 134), 28 (*Fig.* 137)., Of these, 15 shows a near approach to the tripartite variety. The child has a double harelip, incomplete on both sides. I regard the partial closure of the lip as the factor which has prevented the separation of the three processes. Perhaps *Case* 27 should be put in the next category. *Case* 24 shows an unusually wide gap between the segments ; closure of the harelip almost abolished the gap in three months. *Cases* 18, 28 (*Fig.* 137), 35, and 42 (*Fig.* 157) show an unattached septum. It is far more common to get partial attachment to one or other side of the cleft, usually the right. Oblique and irregular septum is shown in 23, 24, 26, and 27. Note the inferior turbinal in 24, well seen also in the tripartite palates.

3. *Cleft of Soft and part of the Hard Palate.—Cases* 35, and probably 27 and 28 in the last series, show this variety. They show well the variations in the slope of the segments and in the degree of arching of the uncleft portions of the

palate. *Case* 47 (*Fig.* 166) shows a palatine arch which is very steep. This shape of the alveolar arch is not uncommonly found along with old-standing cleft, and might, I think, be attributed unfairly to scarring, had operation been done successfully at an earlier date. Clefts apparently of the soft palate alone, frequently involve the posterior part of the hard palate in addition.

Cases 42 (*Fig.* 157), 35 and 18, show cleft with rounded anterior end, a type very difficult to close by Langenbeck's method, but comparatively easy by Lane's.

4. *Cleft of the Soft Palate only.*—*Cases* 10, 13 and 49 (*Fig.* 169) belong to this class. The photograph of 49 shows the height of the uncleft portion of the arch. The remaining varieties are infinitely rarer.

5. *Premaxillary Cleft on one side.*—Cases have been described by Mason,[10] Keith,[11] and others.

FIGS. 120, 121.—*Case* 23. Age 7 weeks. Showing premaxillary projection and oblique septum. Spontaneous closure of alveolus after closure of palate at 10 months.

6. *Premaxillary Cleft on both sides.*—Keith,[12] and Berry,[13] have examples of this deformity. In *Case* 38 (*Fig.* 153), I am able to show a very interesting specimen of this rare variation. The soft palate, as well as the hard palate behind the complete premaxillo-maxillary fissure, is normal.

7. *Central Cleft in Hard Palate.*—Berry[14] has a drawing of such a case.

8. *Absence of the Premaxilla.*—Keith,[15] Bland-Sutton,[16] and others have recorded examples.

9. *A Slight Mesial Premaxillary Cleft* occurs very occasionally (Berry[17]). The growth of the globular processes which go to form the middle third of the upper lip and premaxillary palate has been arrested at an early stage, and a mesial cleft is thus left in the lip and palate. Median harelip has been figured by Clutton, Owen, Pitts, and others. In this case the globular element is bifid but not absent. Berry (Mr. Dun and Dr. T. A. Watson's cases[17]) has two excellent photographs.

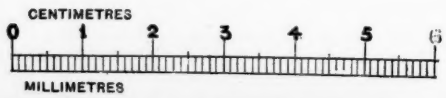
Growth of Segments in Cleft Palate before Birth.—His believed that clefts in the palate resulted from irregular and inco-ordinated growth of the three elements which go to form it. Irregularity of growth certainly does occur in the later months of fœtal life.

FIG. 122.

FIGS. 122–126. *Case* 24.

FIGS. 122–124. Age 9 months. Note premaxillary projection, wide anterior cleft, very oblique vomer, inferior turbinate bone, convexity of rugose area.

FIGS. 125, 126. Age 2½ years. Closure of alveolus, open bite owing to late closure of harelip.



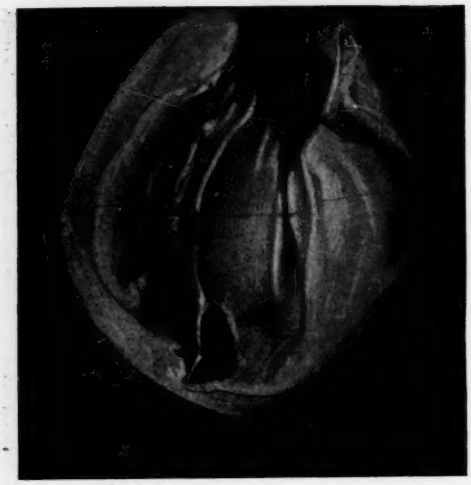


FIG. 123.

FIG. 125.

FIG. 124.

FIG. 126.

The septal part of the mesial nasal process is abnormally long, so that the premaxillary projects often some 6 or 8 mm. in front of the maxillary parts of the tripartite palate, this increase in length occurring in the premaxillary and not in the vomerine part of the septum. If the premaxilla becomes attached to the maxilla on one side, the extra growth of the septum still takes place, so that the premaxilla is bent towards the side on which union takes place. If the septum is attached to the palatal process of either maxilla, it is oblique instead of vertical. As it was vertical originally and has united to one side of the palate, subsequent irregularity of growth has produced this obliquity. Hence, according to Keith[18] irregularity of growth is not the cause but the result of the cleft condition. Examples of these peculiarities of growth can be found in *Cases* 22, 23 (*Fig.* 120), 24 (*Fig.* 122), 26 (*Fig.* 131), and especially in 25 (*Fig.* 127), 36 (*Fig.* 151), and 29 (*Fig.* 139).

FIG. 127.

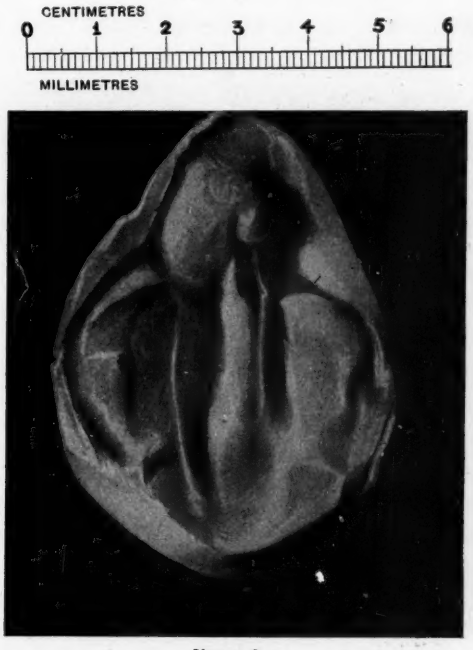


FIG. 128.

FIG. 129.

FIGS. 127-129.—*Case* 25. Age 6 days. Tripartite palate. Premaxillary projection. Long curved septum. Wedge removed from septum, and lip closed in two stages.

Keith, in the paper just referred to, produces evidence that the processes which form the palate are in contact during the fifth and sixth weeks of development. If for some reason union is delayed, growth in the several elements of the palate causes them to separate, and once a breach in their continuity has been effected, union cannot afterwards take place. The younger the fœtus the smaller the cleft, not only absolutely but relatively. The width of the fissure between the palatal processes of the superior maxilla varies from 7 to 20 mm. the tripartite palate (in cases of my own from 7 to 19 mm.); 14 mm. is the

average in eight full-time children; in a fœtus at the fourth month this cleft measured only 1 mm. Brophy has suggested that the subsequent separation is caused by pressure of the lower jaw and tongue against the palate, and with this Keith agrees. Brophy also states that there is no atrophy of the parts that go to form the palate, but this is certainly not the case in Keith's specimens, as he says that "in three palates of adults the cleft was in the average 20 mm. wide, the breadth of the palate 64 mm.; the bony parts of these palates were thus 10 or 15 mm. less than normal. In newly-born children the deficiency affects the inner or marginal area of the palate, but it does not amount to more than 3 mm. on each side."

Most observers disagree with Brophy on this point; and Joseph Griffiths, of Cambridge, has pointed out the probable reason for a mistake which he thinks surprising in a dental surgeon. He suggests that the measurements are compared, not with normal palates in infants of the same age and size, but with the corresponding lower jaws of the cases examined. At all ages, the upper jaw is broader than the lower: and when the molar teeth have erupted it will be found that the upper ones have their long axes directed downwards and *inwards*, while the lower look directly upwards, as in the diagram (*Fig.* 130). Failure to allow for this difference in width makes it appear that there is no loss of substance, while proper allowance makes it clear that the amount of bone in the cleft palate is less than normal. The following measurements illustrate these points:—

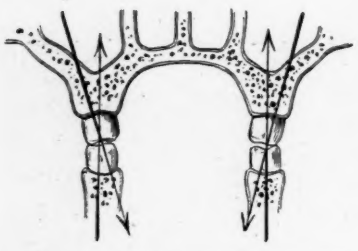


FIG. 130.—DIAGRAM SHOWING THE CONVERGING AXES OF THE UPPER MOLARS.

RELATIVE MEASUREMENTS OF THE UPPER AND LOWER JAWS IN NINE INFANTS.

No.	Sex and Age	Width of Upper Jaw	Width of Lower Jaw	Difference
I	F., 3 m'ths (Case 39)	35 mm.	34 mm.	1 mm.
II	M., 3 months	33·5 ,,	29 ,,	4·5 ,,
III	F., 4 ,,	35 ,,	30 ,,	5 ,,
IV	F., 5 ,, (marasmic)	28 ,,	27 ,,	1 ,,
V	F., 6 months	36 ,,	35 ,,	1 ,,
VI	M., 6 ,,	39 ,,	36·5 ,,	2·5 ,,
VII	M., 7 m'ths (Case 38)	34·5 ,,	33 ,,	1·5 ,,
VIII	M., 9 months	37 ,,	36 ,,	1 ,,
IX	F., 19 m'ths (Case 22)	40 ,,	39 ,,	1 ,,

Nos. I, VII, and IX have cleft palates, the remainder have not. Not only is the upper jaw wider than the lower in all cases, but its total width, which in the three cases given includes the cleft, bears the same relation to the width of the lower jaw as it does in the uncleft cases. Applying Brophy's method of reasoning to the three cases of cleft palate, we find:—

No.	Sex and Age	Width of Upper Jaw	Cleft	Width of Segments	Width of Lower Jaw	Deficiency
I Case 39	F., 3 months	35 mm.	7·5 mm.	27·5 mm.	34 mm.	– 6·5 mm.
VII ,, 38	M., 7 ,,	34·5 ,,	6·5 ,,	28 ,,	33 ,,	– 5 ,,
IX ,, 22	F., 19 ,,	40 ,,	10 ,,	30 ,,	39 ,,	– 9 ,,

This table shows that, even allowing for the difference between the upper and lower jaws, there is still a deficiency, or an actual loss of substance, in the segments of the upper jaw at the level of measurement, amounting to 6·5, 5, and 9 mm.; and that therefore closure by compression narrows the upper jaws to an undesirable extent, and reverses the normal relation between the upper and lower jaws.

FIG. 132.

FIG. 131.

FIGS. 131–133.—*Case* 26. Age 8 months. Prominent premaxilla. Wide anterior end of cleft.

FIG. 133.

Anatomy of the Cleft Upper Jaws at Birth.—In addition to the prominent premaxillary process of the tripartite palate, and the long, bent, and oblique septum of the bipartite palate, the premaxilla of which projects forwards on its unattached side, there are other anatomical peculiarities which may be said to be normal in these abnormal conditions. In the tripartite palate, the septum is not only long (and this increase in length appears to be due to overgrowth of its front part), but it is broad, especially at its lower end, and in front where the bone seems to be thicker than normal. The nerve supply of this median segment, including the central incisor teeth, is the nasal nerve, while in the normal child these teeth are stated to be supplied by the anterior dental nerve which

in cleft alveolus cannot bridge the opening. Hence operations for replacing the prominent premaxilla should be planned with due regard to the position of the nasal nerve which crosses the part from which the usual V-shaped wedge is removed. Where the cleft is not complete and the septum is median and free, it is narrow and not broad, and in nearly all cases the vomerine portion is ill-developed and not prominent, rarely being attached as far back as normal; this seems to suggest that the septal process of Frazer has, like the palatine process, failed to develop fully and to unite as it should. It may even be that the vomerine element is wanting, but it is impossible either to prove or disprove this except by dissection. Mr. Berry[19] says, "At the lower part of the septum a thin shell of bone may be present, forming a sort of casing to the cartilage." In the bipartite palate, Keith describes on each lateral or maxillary element, three definite areas which are visible in many of the accompanying cases, and are of great practical importance. They are :—

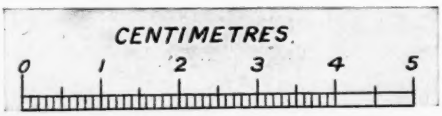


FIG. 134.

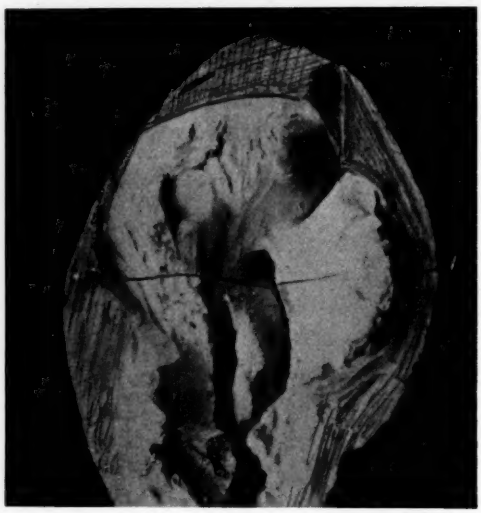


FIG. 135.

FIGS. 134–136. *Case 27.* Age 6 months. No operation has been done on lip. Almost bipartite palate. No premaxillary projection. Septum almost free and very oblique.

FIG. 136.

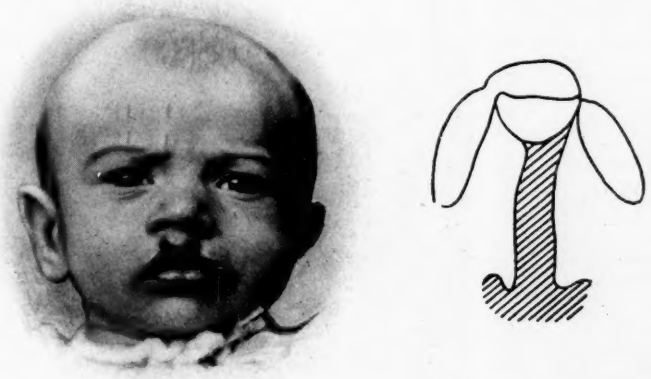
1. The alveolar area (outermost).
2. A plicate or rugose area (intermediate).
3. A smooth narrow marginal area.

In the bipartite palate this last is continuous in part at any rate with the septal mucous membrane on one side. This area is important in the reflection of Lane's flap, and also in Langenbeck's operation.

The rugose area, in the infant at any rate, is invariably, as Griffiths of Cambridge has insisted, convex towards the mouth, and not concave as it is so

frequently figured. *Cases* 24 (*Fig.* 122), 25 (*Fig.* 127), 26 (*Fig.* 131), 27 (*Fig.* 134), 28 (*Fig.* 137), bear this out. Griffiths also points out that whatever the slope in the sides of the cleft, in the skeleton the palatal processes of the palate bones are always strictly horizontal.

At birth, the slope of the divided segments varies considerably in different cases, and there are considerable variations in different cases in the degree of arching of the undivided portion in incomplete clefts of the hard palate. In some, the uncleft portion of the palate appears centrally very highly arched, as in certain cases of adenoids, while in others this is not noticeable. At birth, too, the soft palate rarely appears of normal length, though the amount of tissue may not otherwise appear to fall far short of the normal. Dissections at a later period show the tensor and levator palati well developed; the upper part of the superior constrictor and the palato-pharyngeus are stronger than in normal palates. Adenoids even in the new-born, are extremely common. Even in the tripartite palate the septum, though free, is by no means always central or even straight (*Cases* 25, 36, *Fig.* 151; 29, *Fig.* 139), and the forward projection in a bipartite palate is sometimes restrained if the lip is incompletely cleft (*Cases* 15, *Fig.* 118, and 27, 28).



FIGS. 137, 138.—*Case* 28. Age 2 months. Bipartite palate, but no premaxillary projection.

In normal palates, curious variations of the palatal arch often occur, due either to irregular growth or to abnormal softness or mobility of the palatal processes and of the septum nasi. It appears as if undue growth of the palatal segments, along with pressure from the tongue and lower jaw, accounts for the high palatal arch often seen entirely apart from nasal obstruction, and may account also for many of the very numerous cases of deflected nasal septum not due to injury. Similarly, undue growth of the septum may result in a palate not highly arched, and be responsible for the median ridge occasionally seen upon the oral surface of certain palates. Proper co-ordination of the growth of these three processes before the alterations due to respiration have come into play, seems as important a factor in the proper development of the normal palate as it does in the abnormal or cleft palate. For these variations in the slope of the arch are found in both. (*See Figs.* 168, 169, 170.)

Post-Natal Development and Growth in Cleft Palate.—There are many points of importance here. Keith says: "Whether the cleft continues to increase after birth I am not in a position to say, but judging from the width of the cleft in the adult palate, I conclude that the parts do not continue to

separate after birth at the rate they did before birth." Upon this point depends a good deal of the rationale of the late operation, and there is abundant evidence to decide it. The incomplete cleft becomes not only relatively but actually narrower as time goes on, except perhaps in some of the cases in which the

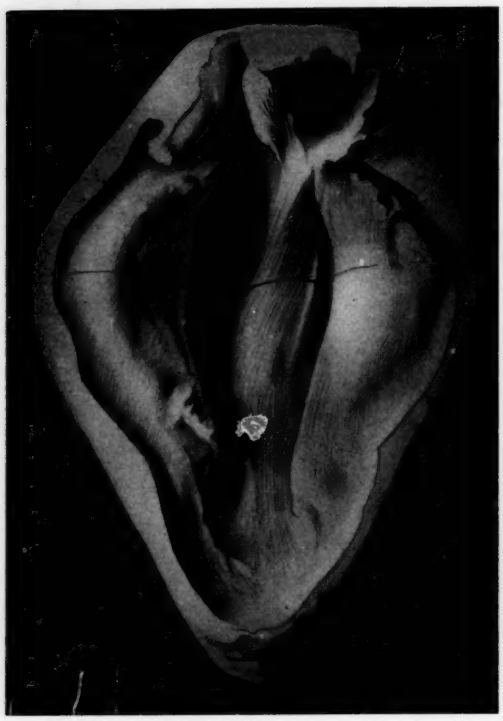


FIG. 139.

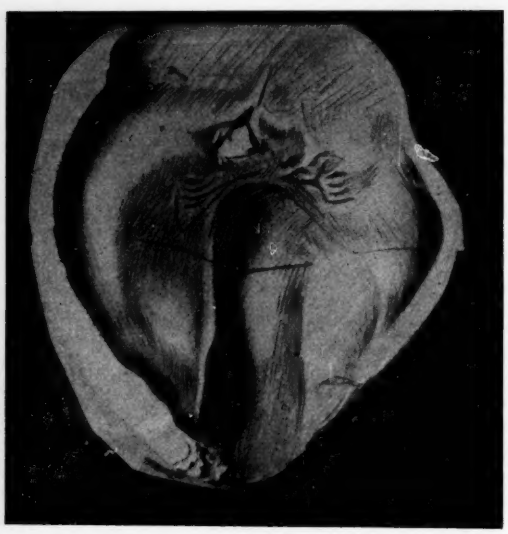


FIG. 141.

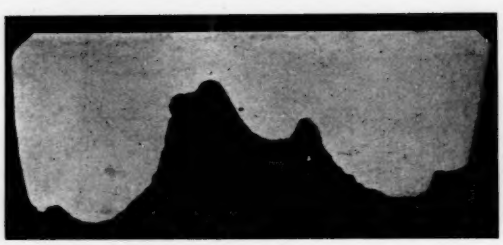


FIG. 140.

FIG. 142.

FIGS. 139-142.—*Case* 29. Figs. 139, 140 show condition at 4 days. Very prominent premaxilla; long oblique septum bent to left; wide cleft. Figs. 141, 142 show premaxilla pressed back after closure of lip. Incisor tooth directed backwards and downwards.

anterior end is wide and rounded; the complete cleft where the harelip is closed by operation (*Cases* 22, 23, and 44) invariably closes at the alveolar margin, even when (*Case* 24) closure of the lip has been deferred to a relatively late period of time. Mr. James Berry[20] (at the Birmingham meeting of the B.M.A., 1911), showed, as far as my memory serves me, a series of drawings of the same palate

at different ages, and a series of drawings of different palates at increasing ages, in none of which had operation been performed. They showed conclusively that the cleft becomes progressively narrower as time goes on, and may, as far as the anterior part of the hard palate is concerned, become obliterated altogether. At the same time the segments of the roof become steeper as a rule, and since growth in cleft palate is not abolished, the palatal area becomes greater. This diminution in the width of the cleft is most marked when the cleft was originally complete; I know of no measurements showing diminution in the width of a cleft of the soft and part of the hard palate, with a wide rounded anterior end, though it is presumable that there would be some even in that case. It is in this variety that we are struck by the apparent loss of substance in the soft as well as in the hard palate, for the older the patient the more difficult it is to approximate the two edges of the cleft in the soft palate. In the child of two or three years of age, the uvula at any rate, often has its component halves in actual contact. So that closure of a cleft by a median operation is at first usually impossible, then it becomes increasingly easy up to a point, after which there do not appear to be sufficient advantages to make the operation a necessity.

ARCHITECTURE OF CLEFT PALATE IN RELATION TO OPERATION.

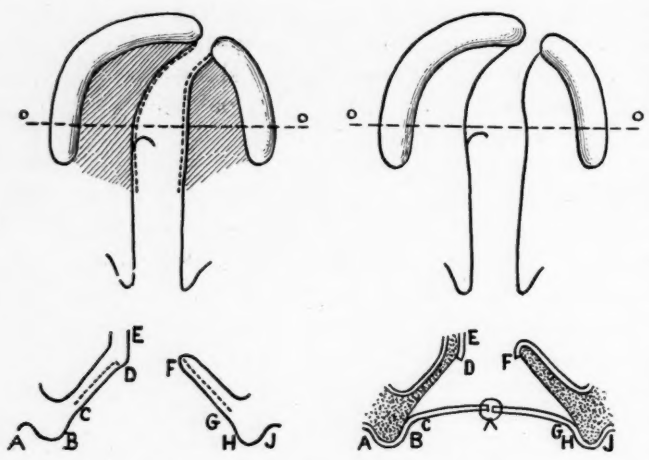
In order to consider in a logical way the various procedures used for the closure of a cleft in the palate, it is necessary to study the normal architecture of the cleft palate. This will determine for us not only the amount of material with which we are to work, but also the mechanical conditions which limit its employment. Let us leave the soft palate out of the question for the moment, and consider a complete cleft of the hard. [The gap may be obliterated by forcibly pressing the bones together (Brophy), but this method is not at present under discussion.] The muco-periosteum is, subject to certain restriction with regard to its vitality, separable from the bone, and this is actually done in performing the operation in most of the recognized methods.

In *Langenbeck's method* separation of this inelastic muco-periosteum is complete at the margins of the cleft; and if the cleft is not too wide, and the amount of tissue is sufficient, or the slope of the segments of the arch sufficiently great, the margins of the cleft can be brought into contact without further interference. If, however, the margins of the cleft will not meet by this means, lateral cuts at or near the alveolar margin may enable them to do so. I am not considering here the proper way of attaining this end, but merely the mechanical problem involved. *Figs.* 143 and 144, 145 and 146, illustrate the rationale of the method.

Figs. 143, 144, represent a palate in which the sides are steep. Let **A B** and **H J** represent the gums in a vertical section at level **O, O**; **B D** and **H F**, the muco-periosteum of the hard palate; **D F**, the cleft; **D E**, the septum attached to one side.

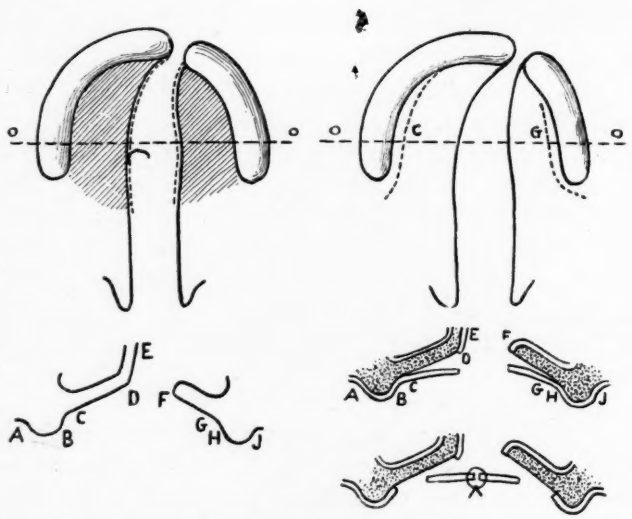
Then if the muco-periosteum be separated at the margins of the cleft, undermined as far back as **C** and **G**, the margins **D** and **F** can be approximated and made to meet, because the width of tissue **C D + F G** is greater than, or equal to, the distance **C G**.

On the other hand, in *Figs.* 145, 146, where the slope of the segments is slight, the width of tissue C D + F G is considerably less than the distance C G, and therefore the margins D and F cannot be brought into contact unless lateral incisions be made, crossing the section, at say C and G, which leaves lateral gaps upon the bone, or unless some of the mucous membrane of the vomer be used (a help which is often useful but cannot be relied upon). So that we have to deal, not with the actual width of the cleft, but with its width relative to the other factors, namely, slope of the arch (i.e., height of the palate) and width of the separable periosteum. In a palate where the arch is low, we have also to deal practically with the limits of safety for extending the lateral incisions, and with the possible effect of scarring on the mobility of the soft palate.



FIGS. 143, 144.—Steep sides, high arch.

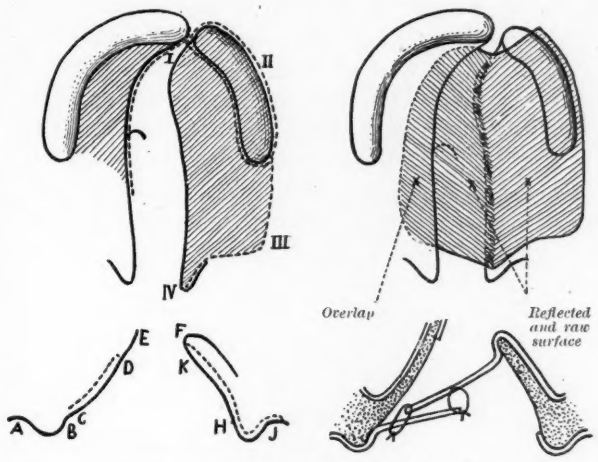
Arbuthnot Lane's Modifications of Davies-Colley's Operation.—Here the method is entirely different. An incision is made along the alveolar border, outside or inside the teeth-line, according to the breadth of flap required, of that side of the cleft unattached to the septum, the muco-periosteum is separated towards the cleft, and the flap so produced is turned over and hinged at the cleft. The other side is treated either as in Langenbeck's method, but without the lateral incision, or by undermining and sliding a flap hinged behind, at or near the exit of, the posterior palatine vessels. Thus *Figs.* 147, 148 represent a highly-arched palate and therefore a relatively narrow cleft. The incision I, II, III, IV, is made outside or inside the teeth, and the muco-periosteum (and mucous membrane of the soft palate) is separated, raised and turned over,



FIGS. 145, 146.—Slight slope, low arch.

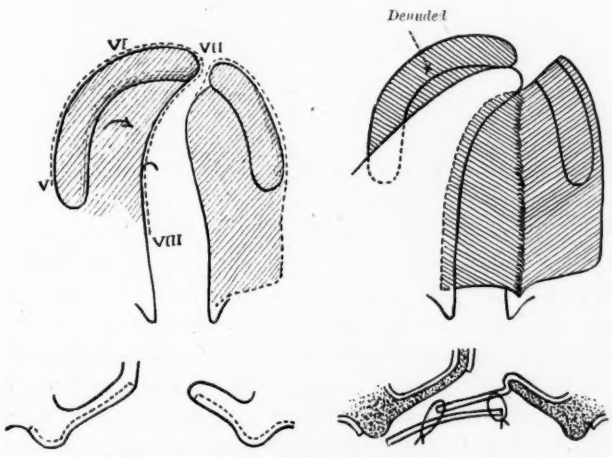
and hinged at I–IV. The other side is treated as regards the hard palate and the separation of the soft palate from the bone, as in Langenbeck's method. The turned-over flap is tucked under the Langenbeck flap of the other side, by which latter it is overlapped to a varying extent.

Figs. 149, 150 show a relatively wide cleft. Incision is made on the vomer-free side as before. On the other side incision V, VI, VII, VIII, may be made outside or inside the gum as required, and along the margin of the cleft (or including part of the mucous membrane of the vomer); the flap is hinged at V–VIII, and is then made to overlap the first-made flap. Description of the more complicated procedures would serve no useful purpose, for reasons mentioned later. The method shown in *Figs.* 147, 148, with the flap separated within the teeth, is the only one I now employ. Note that incisions outside the gums expose the milk teeth.



FIGS. 147, 148.—Showing a high arch.

The mechanical factors in Lane's operation are the actual width of the cleft, and the effective width of the reflected flap H K in *Fig.* 147. In certain cases also, the angle through which the flap V, VI, VII, VIII, in *Fig.* 149 can be rotated to make overlap possible or to increase it, is an important factor. Practically, I have found that one can generally get a greater degree of overlapping than appears theoretically possible; while in Langenbeck's operation, since the edges of the soft palate have to be pared, the degree of approximation of the segments is less than theoretically it should be.



FIGS. 149, 150.—Showing a low arch.

The figures given above are purely diagrammatic for both forms of operation; they are not complete, nor do they explain the technicalities of the methods.

Speaking generally, it may fairly be assumed that if the hard palate can

be closed the soft palate can be also, so that measurements on the hard palate are all that are necessary for a theoretical consideration of the possibilities of an operation. Let us, therefore, examine actual palates in order to get an idea of the practicability of operation in each case, apart entirely from the advisability.

It will be seen by measurement of the annexed cases, that Langenbeck's operation can never, and that Lane's operation as I have described it hitherto can only rarely, close the whole of the wide anterior end in a bipartite palate.

The sections of casts figured show conclusively that it becomes theoretically easier to close a palate by Langenbeck's operation the older the patient is. This is practically true up to certain limits of age. Also that Lane's method is theoretically possible at any age. They show also that in most cases Langenbeck's operation is impossible in the very young with wide clefts. The other important inference is this: Operations by Langenbeck's method become easier as time goes on, because the anatomy of the cleft alters, for not only does the

FIGS. 151, 152.—*Case* 36. Age 3½ months. Tripartite palate with marked premaxillary projection. Lip closed in two stages after author's oblique section of septum nasi.

actual width of the cleft usually diminish, but the effective width, as judged by the method I have described, becomes materially less as the age increases. Thus, in the table of measurements on page 275, *Cases* 30, 32, and 34, are all over three years of age: *Cases* 30 and 32 showed actual overlapping of the segments after separation, while 34, in which the deficiency could not be reduced to less than 4 mm., for this and other reasons had to be closed by Lane's method. It must be remembered also that a deficiency of a few mm. in the large palate of an older patient can be more safely compensated by lateral incisions than in a small palate.

As a final step in this anatomical survey, one must consider the soft palate. My own belief is that there is usually less tissue in the cleft soft palate than in the normal, and that it is only rarely possible to fashion a long enough soft palate from the material at our disposal. The soft palate is of course elastic; this has the advantage that it can be stretched to bridge the gap, but being a muscle

it is not thrown entirely out of action, even temporarily, by operation, so that the sutured edges are likely to be torn apart. Lateral incisions, especially if extensive, must to some extent damage its future movements. Again, a quadrate sheet of elastic tissue if pulled upon on opposite sides lengthens in the direction of the pull, but inevitably becomes shorter in the axis at right angles. Hence, suture of the palate shortens an already short palate. In Lane's operation, in spite of some statements to the contrary, the cleft is not closed at the expense of the soft palate; indeed, the reverse may be, and frequently is, the case.

FIGS. 153, 154.—Before operation.

FIG. 155.—Result fourteen days after operation.

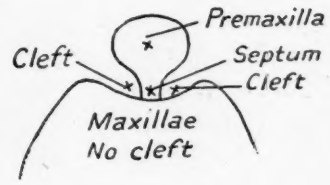


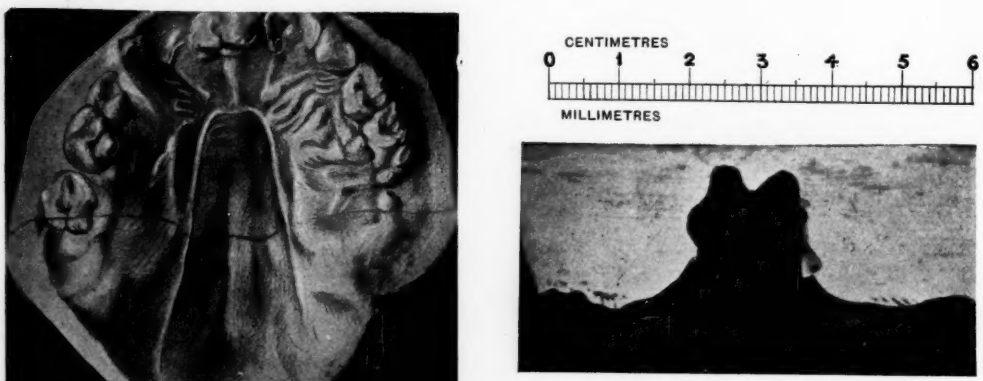
FIG. 156.

FIGS. 153-156.—*Case* 38. Age 7 days. Complete premaxillo-maxillary cleft. No inter-maxillary cleft. Soft palate normal. Much projection of premaxilla. No bony operation. Harelip closed in two stages.

But though there is not the disadvantage of the lateral incisions, we must consider the effect of dissecting the mucous membrane off the soft palate—its immediate, and possible remote effects. This operation can of course be performed without harming the muscle much. Personally I have not found it easy. It must be remembered that this has to be done from the oral surface of one segment of the soft palate, and from the nasopharyngeal side of the other segment. It is frequently assumed that there must be in Lane's operation a broad area between the muscle sheaths composed only of the two opposed surfaces of mucous membrane. In the majority of operations this is not the case. By separating on one side the muscle of the soft palate from the bony palatal process of the

palate bone, the muscle on that side can be drawn in to bridge at least half the width of the cleft. At the uvula, and for some distance forward, muscle lies in contact with muscle. There is a narrow wedge-shaped portion where the muscles cannot be made to meet. This is the first anatomical fact to be noted. The second is this: part of the uncovered muscle must, in a certain percentage of cases, be left exposed. Frequently this can be avoided, and the mucous membrane sewn together to obliterate the defect. In such a case, from the point of view of anatomy and of function, the muscle is undamaged, and experience shows that a good and bilaterally mobile soft palate results.

Where this closure cannot be made complete, the gap may be greatly diminished by undercutting and suture. If any gap remains, healing of this by granulation is the inevitable result, and some scarring is certain. This must shorten and immobilize to a certain extent the new soft palate. Practically the shortening is the more important factor, and there is no doubt that short



FIGS. 157, 158.—*Case* 42. Age 6½ years. Wide cleft with rounded anterior end. Free vomer. A type difficult to close. Note rugose and marginal areas.

soft palates are frequent after Lane's, as well as after Langenbeck's, operation. The practical effect of this on speech will be referred to later.

The following table gives measurements of the clefts in nineteen cases, in four of which two observations have been made before and some time after the closure of the accompanying harelip. This table shows the measurements necessary for determining the theoretical possibility of Langenbeck's and Lane's operations. The cases are arranged in order of age, and the diagrams, *Figs.* 159, 160, will explain the interpretation of the column. The measurements are taken at the widest part of the cleft.

The table shows the relation between the age of the patient and the width of the cleft, or what is more important, the effective width.

Examined as a whole it shows no regular gradation in the width of the cleft as age increases. This confirms the statement that no two palates are alike, and that every case must be treated on its own merits. Hence no hard and fast rule for the time of operation can be laid down.

TABLE OF MEASUREMENTS IN NINETEEN CASES OF CLEFT PALATE

Column I. (Distance *a* to *d*, *Figs.* 159, 160) shows the width of the palate measured from just inside the line of the teeth at the point where Langenbeck's lateral incision is made. *Column II.* (=*a b* + *c d*) shows the total width of the segments of the divided arch measured from the same points. The difference between these figures (*Column III.* =*b* to *c*) shows the effective width of the cleft, i.e., after separation of the muco-periosteum in Langenbeck's operation. If positive, it indicates the total width of the lateral incisions. If this is large in comparison with the size of the palate, Langenbeck's operation is inadvisable. A negative figure shows that the segments will overlap. *Column IV.* (=*b* to *c*) gives the actual width of the cleft; *Column V* (=*c* to *e*) the maximum width of the reflected Lane's flap; and *Column VI.* (=*c* to *d*) the width when the line of the teeth is not transgressed; the figures indicating an overlap, and the failure of the flaps to meet. The relation between *Columns V* and *VI*, and *IV* gives the theoretical possibilities of Lane's method. *Column VII* (A=*c e* − *b c*, B=*c d* − *b c*).

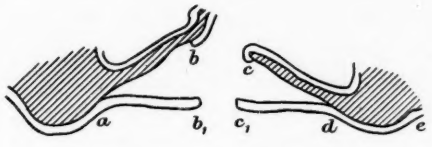


FIG. 159.—LANGENBECK'S METHOD.

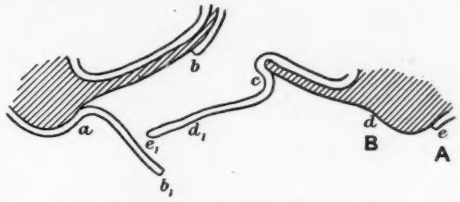


FIG. 160.—LANE'S METHOD.

			I	II	III	IV	V	VI	VII	
	CASE	AGE	WIDTH OF PALATE	TOTAL WIDTH OF SEGMENTS	EFFECTIVE CLEFT (LANGENBECK)	ACTUAL CLEFT	WIDTH OF LANE'S FLAP (A) MAX'MUM	WIDTH OF LANE'S FLAP (B) INSIDE TEETH	OVERLAP in A	OVERLAP in B
			mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Tripartite Palate	29 A	4 days	30	17·5	+ 12·5	18	19	13	+ 1	− 5
	25	6 ,,	28	21	+ 7·5	18	17	13	− 1	− 5
	36	3½ m'ths	21	21	—	15	—	—	—	—
	29 B	15 ,,	33	26	+ 9	13	18	13	+ 5	—
Bipartite or Incomplete Cleft	28	2 ,,	27·5	22	+ 5·5	14	—	—	—	—
	22	3 ,,	25	24	+ 1	14	—	—	—	—
	44 A	3 ,,	27	24	+ 3	9·5	17·5	11	+ 8	+ 2·5
	44 B	5 ,,	30	25?	+ 5	13	17	13	+ 4	—
	48	7 ,,	23	19	+ 4	5	13	9	+ 8	+ 4
	24 A	9 ,,	28	24·5	+ 4·5	18	15	12	+ 4	+ 1
	26 A	9 ,,	23·5	22·5	+ 1	15	—	—	—	—
	27	9 ,,	25·5	19	+ 6·5	11	16	12	+ 5	+ 1
	26 B	12 ,,	27	25	+ 2	13	16	13	+ 3	—
	24 B	2½ years	38	37	+ 1	20	—	21	—	+ 1
	30	3 ,,	18·5	23	− 4·5	8	—	—	—	—
	42	6½ ,,	37	24	13	16	20	15	+ 4	− 1
	34	7 ,,	29	25	+ 4	19	—	—	—	—
	32	12 ,,	16·5	24	− 7·5	12	—	—	—	—
	47	20 ,,	34	29	+ 5	14	23	16	+ 9	+ 2

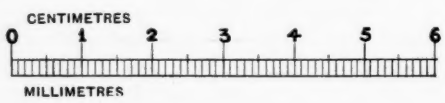
(When the ages of the patients do not correspond to those in the final table, it is to be understood that the observations were made at different periods.)

It will be seen that in nearly all the cases, Lane's operation is feasible with either the full or restricted flap. Practically the overlap is made greater by the separation of the opposite side, and is always much greater at the junction of the hard and soft palates.

FIG. 161.

FIGS. 161–163.—*Case* 44. Age 3 months. Before closure of lip.

FIGS. 164, 165.—Two months after closure of lip. Marked projection of premaxilla. Septum very oblique.



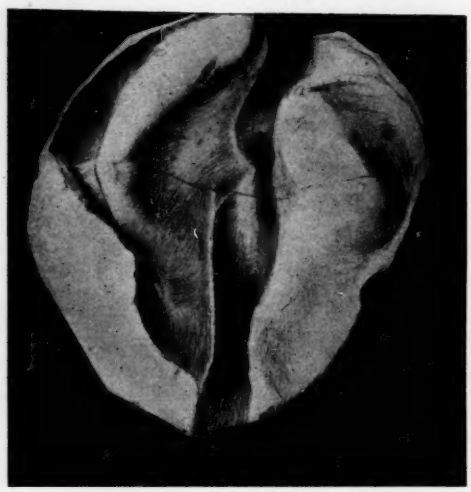


FIG. 162.

FIG. 164.

FIG. 163.

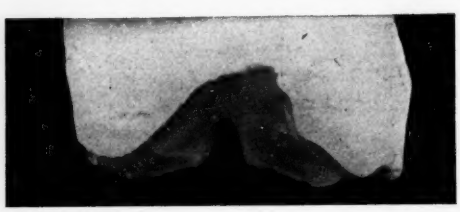


FIG. 165.

The effects of growth on the cleft palate are best shown by measurements on the same palate at different ages. I give four examples. *Case* 29 (*Fig.* 139) is a

tripartite palate, in which the premaxilla was replaced and the harelip closed in two stages. There has been a diminution in the width of the cleft of 5 mm. in fifteen months; Langenbeck's operation was impossible at first, since the united width of the segments was less than the width of the cleft, whereas a wide Lane's flap will close the gap at birth, and a restricted flap at the later age. In the bipartite palates, closure of the lip has resulted in every case in spontaneous closure of the alveolus. In *Case* 44 (*Fig.* 161) there has been some growth of the palate in two months, and a slight increase in the width of the cleft. Operation is theoretically possible, but at present inadvisable. *Case* 26 (*Fig.* 131) shows that in three months there has been increase in the extent and steepness of the segments, and the cleft has become a little narrower. In *Case* 24 (*Fig.* 122), after an interval of nearly two years, a gap of 14 mm. between the alveolar margins has been abolished; there has been 10 mm. increase in the width of the jaws, but only 2 mm. in the width of the cleft, which could now be closed by Langenbeck's method with lateral incisions of moderate extent.

FIGS. 166, 167.—*Case* 47. Age 20. Note contraction of anterior portion of palate. Had operation been done, this contraction might have been attributed to scarring.

THE ANATOMY AND PHYSIOLOGY OF NORMAL SPEECH.

So much misconception appears to exist on this subject, that it is necessary to consider it somewhat fully; especially as speech is the ultimate criterion by which the results of a cleft-palate operation must be judged.

The human musical instrument has been often compared to a reed organ pipe.[21] Here there is not only the vibration of the column of air, but also of a reed, which corresponds to the vocal cords in the air chamber composed of the trachea and the bronchial system beneath it. The pharynx, mouth, and nasal cavities above the glottis are resonating cavities, which by alterations in their shape and size are able to pick out and emphasize certain component parts of the fundamental tones produced in the larynx.

Musical sounds differ from one another in three ways:—

1. IN PITCH.—This depends on the rate of vibration of the vocal cords. Different notes are obtained by alterations in the tension of those cords.

2. In Loudness.—This depends on the amplitude of the vibrations, and is increased by the force of the expiratory blast which sets the cords in motion.

3. In "Timbre" or "Quality."—The difference of character which distinguishes one voice from another is due to admixture of the primary vibrations with secondary vibrations or overtones. The richer the voice the more numerous are these overtones or harmonics. They are produced, or rather brought out or accentuated, not in the larynx, but in the resonating cavities, the mouth, the nose, and the accessory cavities above the larynx.

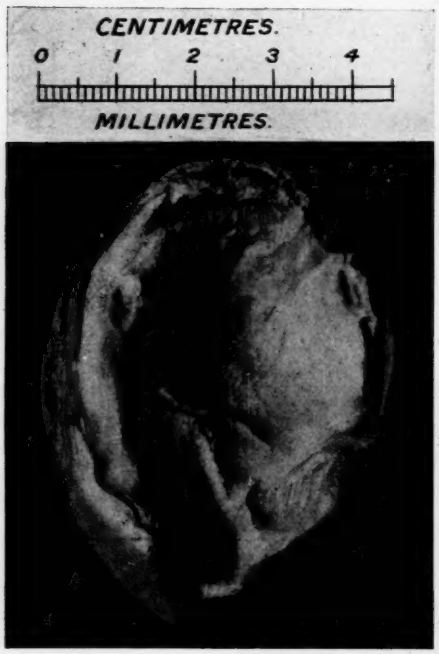


Fig. 168.—*Case* 19 Cast taken at about 2 years. Note the high palatal arch and cleft of soft palate.

Fig. 169.—*Case* 49. Cleft of soft palate. Note arching of uncleft portion of pharyngeal wall against which soft palate is pressed.

Fig. 170.—*Case* 49. Palate closed by Lane's method. No raw surface left.

Speech.—This is due to the modification produced in the fundamental laryngeal notes by the resonating cavities above the vocal cords. "By modifying the size and shape of the pharynx, mouth, and nose, certain overtones or harmonics are picked out and exaggerated; this gives us the vowel sounds." *They have nothing to do with articulation.* "The consonants are produced by interruptions, more or less complete, of the outflowing air in different situations." *This is articulation.* "The soft palate is raised at each word. When the larynx is passive, and the resonating cavities alone come into play, then we get whispering."[21]

Elementary as these distinctions seem, it is surprising how much confusion exists. It is commonly believed, for instance, that the pitch of each of the vowels is different; and yet all of them can be sung on one note. Hence the fundamental tone is the same for each, though the harmonics are different; the pitch of the most pronounced of the overtones in the different vowels is different, and in that sense it is true "U has the lowest pitch, then O, A (as in father), I, and E."

It is when we consider the consonants that we realize the difference between articulation and voice production.

In the articulation of all consonants (with the exception of the voiced nasal resonants M, N, NG) the soft palate is raised *so as to shut off the oral cavity from the nose.* The stream of air during phonation is thus driven through the mouth. By the narrowing or complete closing of the oral channel at certain points, the various consonants are produced.[22]

Thus we have to consider, apart from the pitch of the voice, two separate features : first and foremost, the *articulation* ; and, secondly, the *quality* or *timbre* of the voice. In addition, in cases of cleft palate, we have to consider the methods by which they produce their *words,* and the character of the sounds they produce.

Careful study of the mechanism of articulation shows the necessity for the integrity of the palate in the production of the consonants (except M, N, and NG). For perfectly natural articulation *the soft palate must not only be sufficiently mobile but also sufficiently long to shut off the nasal from the oral pharynx.* It must reach what is sometimes known as Passavant's ridge.[23] If that is not the case, a true nasal element is added to the sound, which cannot be got rid of without special training in articulation. This is required even in the very few cases in which the soft palate is sufficiently long and mobile, because the muscles are not accustomed to act in a normal way, and the patient has to be re-taught to speak. It follows also, that if the cleft be closed in infancy before the child has begun to articulate, unless the palate can be made sufficiently long and mobile, habits of faulty articulation cannot be prevented. When we admit, as I think we must, that few, if any, patients after cleft-palate operations speak normally without special training, we are more likely, I think, to find the explanation in the shortness of the soft palate than in any other factor. If it could be shown that early operation produced a longer soft palate than later operation, permanently as well as temporarily, early operation would be in a very strong position. This proof is not yet before us.

Sir W. Arbuthnot Lane also says :[24] " The reason that the patient's intonation is peculiar, or as it is usually called, nasal, is that the outgoing air does not pass through the nose, and when the cleft is closed at the usual time, there is in the extremely undeveloped nose very little space through which air can be transmitted." He evidently refers to the so-called nasal voice commonly associated with nasal obstruction. In the common cold, for instance, it is due to congestion of the turbinate bones. In nasal obstruction from adenoids, also, the occasional alteration of voice is fairly typical, but it is not nasal. It might more accurately be described as thick. The conditions here referred to are quite different from those found in cleft palate, or immediately following operation for this condition. The trouble then is, that too much air escapes through the nose, and cannot immediately be prevented from doing so. As Mr. Berry points out,[25] most of the facial contortions found in these patients are due to their efforts to prevent the escape of air from the nostrils. He says also, that the removal of adenoids in a patient with cleft palate makes the speech worse. Case No. 14 of my series, where a cleft in the soft palate had been closed in infancy, when five years old talked no better than if the cleft had never been touched. There were a short soft palate and adenoids. Removal of these made the speech still worse, although the capacity of the nasopharynx was increased by the operation. As I have just pointed out, the mal-development of the nasopharynx, since it is one of the accessory resonating chambers, may influence the character or " timbre " of the voice, but *per se, it can have no effect on articulation.* Bearing these facts in mind, it is easy to prophesy from the appearance of the cleft what will be the peculiarity of the speech. Thus, in a wide cleft of the soft palate, except for M, N, NG, none of the consonants can be sounded as clearly, loudly, or forcibly as in a normal person. The explosives P, B, T, D, K, G, are especially likely to be weakened ; of these the voiced explosives B, D, G, tend to be converted into the corresponding voiced nasals M, N, NG. Hence, as Berry says, " in this respect the articulation of a cleft-palate patient is the converse of that of the patient with a cold in the head." The more extensive the cleft, the more difficulty is there, especially with the consonants formed at the third-stop position, K, G, CH, H, and Y. Application of the tongue to the

posterior edge of the uncleft hard palate makes their articulation possible in a manner. If the hard palate be involved, the consonants of the second-stop position cannot be normally produced, with the occasional exception of L; while cleft of the alveolar arch, or absence of the teeth, affects in addition the consonants of the first-stop position, particularly S, Z, and TH.

The speech of the cleft-palate patient is therefore likely to be indistinct as to articulation. In character it is often explosive, efforts at correction merely making the child speak more loudly. It is often accompanied by whiffing or whistling noises, due to the escape of air from the nostrils, and by spasmodic facial contortions, which aim at closure of the nostrils. The superior constrictor of the pharynx also is greatly used, as by the contraction of its highest fibres the width of a cleft of the soft palate can be temporarily diminished. Very much can be done by careful training to improve the speech of these patients. Berry refers to a case of an extensive cleft in the palate where very fair speech was obtained without operation; and at Birmingham, in 1911, he showed several patients who, judging by their speech, were absolutely indistinguishable from normal people. For re-education, however, there must be some capacity in the persons taught. Griffiths, of Cambridge, believed at one time that lack of cerebral development was partly responsible, and that therefore it was unlikely that nervous impulses producing the proper stimuli for movements of the palate and for speech could be induced to travel by normal channels; but he has been able to educate the speech at so late a period of life that he no longer holds the views described above.

For normal speech then the following factors seem essential :—

1. Normal, or nearly normal anatomical conditions, namely: A long and movable soft palate without any perforation, unless very small; a complete hard palate; a complete alveolar margin capable of accurate approximation with the lower jaw, and an efficient lip. Of these, the first is essential.

2. Normal, or if the other factors are not fully present, extraordinary intelligence and response to teaching.

Fortunately the percentage of mentally defective among cleft-palate patients is not very high; and with constant and efficient teaching, the final results, as Berry shows, are very promising. As a last word on this subject, reading aloud, and not singing, must be the criterion of a good result; for as I have shown, singing is a question of vocalization and resonance, i.e. a question of the larynx and accessory cavities, and is often an easy matter for the musical ones among cleft-palate patients. It is only, essentially speaking, very secondarily a question of articulation.

DEDUCTIONS BASED ON THE FOREGOING ANATOMICAL SURVEY.

1. Cleft palate is a developmental anomaly. Until the cleft is closed, proper development of the parts concerned cannot take place. It is advisable, therefore, to close the cleft at the earliest favourable opportunity.

2. Early operation must not damage the structures concerned to such a degree as to prevent proper development afterwards.

3. Developmentally, there appears to be no reason why, up to the birth of the child, the nasal cavities and the accessory sinuses should not grow normally.

4. Since the formation of the antrum is independent of the failure of union of the palate, the possible mal-development of that cavity will not be prevented by early operation.

5. Any early operation which interferes with the development of the teeth may result in mal-development of the antrum.

6. Mal-development of the antrum or of any of the air cavities (the palate being otherwise normal) does not interfere with articulation. Mal-development of the teeth may.

7. Even at birth the soft palate appears to be shorter and smaller than normal. As time goes on, lack of proper growth becomes increasingly obvious.

8. Preliminary operations for the replacement of the premaxilla should be planned so as to spare the nerves of that segment.

9. The causation of the cleft, except in so far as syphilis renders a child weakly and unsuited for early operation, has no bearing on the mode of treatment. Syphilis does not appear to be a common cause.

10. Unless compression of the jaws, as in Brophy's operation, be performed, Langenbeck's operation is inapplicable to the majority of cleft palates during infancy.

11. With certain extensions, Lane's operation is applicable at any and every period of life.

12. A wider cleft can be closed by Lane's operations than would theoretically seem possible from measurements. The reverse is the case in Langenbeck's operation.

13. In Langenbeck's operation, the lateral incisions must cause some degree of scarring on the hard palate, and some degree of loss of function in the soft, if they are carried into the muscle.

14. In Lane's operation, the temporary teeth are, or may be, laid bare. This often results in their early shedding, and an unknown amount of irregularity, and perhaps destruction, of the permanent ones; this may interfere with articulation.

15. In Lane's operation there are extensive raw surfaces on the hard palate which cause a good deal of scarring. There are frequently, though not necessarily, raw surfaces on the soft palate, which, though they do not enter the muscular planes, must scar, and limit to some extent the movements of the soft palate.

16. Langenbeck's operation shortens an already short soft palate. In Lane's this shortening may not be so great, but the increase may be counterbalanced by subsequent scarring.

17. The possibility of closure of a cleft by Langenbeck's method is a question not of its absolute but of its relative width, and of the slope of the segments. In Lane's, the factors are the actual width of the cleft, and the total width of the flap obtainable from one side or segment.

18. Voice production must not be confused with articulation.

19. Unless the soft palate can be made sufficiently long and mobile, operation in infancy cannot prevent the formation of faulty habits of articulation.

20. Mere blockage of the nose does not produce the cleft-palate voice, which is truly nasal, and is due to inability to prevent the escape of air from the nostrils.

21. In any case special training in speech is essential. The majority of patients, if not all, speak abnormally after operation. Early operation will make normal speech more likely only if an efficient soft palate can be fashioned.

OPERATIVE TREATMENT OF CLEFT PALATE.

The choice of an operation is in reality more limited than might at first sight appear, and at any given age more limited still. For, as Mr. Murray[26] of Liverpool points out, although the flap operation can be done at all periods of life, the median one is inapplicable in infancy for wide and complete clefts, unless some preliminary operation such as Brophy's is performed. Of the

possible operations, therefore, I shall discuss three only, and merely mention a fourth which has some importance because of the principles involved. Of operations during infancy we have to consider those of Brophy, Griffiths, and Arbuthnot Lane ; while of operations at a later period we have those of Griffiths, Lane, and Langenbeck. Brophy's operation is limited to the first five months of life at the very most, and ten days to three weeks is the ideal age given. Lane's operations are independent of age, but were introduced to make early operation feasible. Langenbeck's operation is rarely possible before the third year.

Brophy's Operation.—This is essentially a method of reducing the width of the cleft by direct compression. He uses silver wires and metal plates which are left *in situ* until they are no longer required. (The only other means of compression that might have been considered is by means of clamps, such as Ulrich's, a method which its inventor has already abandoned.) Brophy introduced his method many years ago, and after large experience, as Berry says, remains a warm advocate of it. He has a record of 211 consecutive operations without a death. That, of course, though important, is not the chief criterion of success. I have been unable to obtain any record of the after-history of his cases, except the following statement[27] : "Numbers of Brophy's cases have passed the supreme test of reading aloud." As Brophy has also an operation applicable to later life, and it is not stated by which method these cited cases were performed, the statement has not much value as evidence. Still, Brophy's operation appears to have been satisfactory in America. In England, on the other hand, the results as a whole have been disappointing, and in many cases very bad. Edmund Owen has been its chief advocate among English surgeons ; but even he has published no detailed record. The one referred to in his book gives no account of subsequent speech. It is more than possible that English failures have been due to an imperfect understanding of the method, which appears to be by no means as violent a procedure as was at first believed. For a good and full account of the technique, Mr. Berry's description[28] should be consulted.

Griffiths' Operation.—The operation favoured by Mr. Joseph Griffiths, of Cambridge, is important because it is a modification of Langenbeck's, which is applicable to infants. It is practically unknown, as there have been no published cases. Mr. Griffiths depends on two observations of his own : (1) That transverse incisions in the palate heal readily, while longitudinal ones do not ; (2) That the vascular supply of the palate is so good that injury to its main vessels is of no importance, as sloughing of the flaps never takes place. This latter statement is not absolutely correct, though there is much truth in the former. Acting on these beliefs, he separates flaps of the hard palate, hingeing them at about the junction of the hard and soft palates. If they come together without tension, he proceeds to pare the edges of the soft palate and to suture in the middle line. If only the anterior part can be made to meet without tension, he is content to suture that and to leave these separated portions of muco-periosteum literally flapping about in the mouth. Mr. Griffiths says that the flaps soon become fixed in their new position and neither slough nor come apart. At a second operation, if the whole cleft has not been closed, he makes a transverse incision at the anterior end of the remaining cleft towards the lateral borders

of the palate, separates as before, including the freeing of the soft palate from the bone as in Langenbeck's method, pares the margins of the soft palate, and sutures as before. The transverse gaps that may be left at the anterior end of the cleft in either operation close, he says, rapidly and certainly, and he finds the method superior to any other. It is without doubt ingenious, and is based on a long experience as a successful operator and upon reasoning carefully thought out.

Arbuthnot Lane's Operations.—The principle of these operations has already been described and discussed. It has been pointed out that operation can be performed at any age ; certain of the procedures are of course inapplicable when the teeth are cut. Again, almost any width of cleft can be closed before this period, and it must be remembered that we can wait, if it is desirable, nearly eighteen months before the presence of the teeth materially limits the width of the incisions. As certain of the procedures violate some of the canons laid down, I have ceased to perform them, and must refer the reader to the original work for full descriptions. For instance, few surgeons have the manual dexterity of Lane, and an operation to be valuable to the average surgeon should not require too long a time for its performance, especially in an infant. I find myself incapable of closing both harelip and cleft palate in a short enough time, so that I perform each operation at a separate sitting. Again, I have come to believe that the uncovering of the temporary teeth is undesirable ; I have found that it is unnecessary, and have ceased to do it. I have found, in company with many observers, that closure of the harelip in the widest complete cleft, will bring the alveolar margins into contact in less than three months, so that after having done this I can still operate on the palate during the period of infancy if it seems advisable. I have not been hampered in my subsequent procedures by the closure of the lip, so that now I close it first. I have no need, therefore, to use any of the tissues of the lip to close the anterior part of the cleft ; indeed, I never cut away tissue, as there is little enough to spare in any case, and I can manage to utilize it all.

Since I believe also that a movable soft palate should be aimed at and not a mere obturator, I have never used the whole of the hard palate to bridge the soft palate, as Lane describes on page 75 of his book. I have seen the operation done, and it is efficient mechanically, but I doubt if it is right to do it. For somewhat similar reasons I have a theoretical objection to Lane's two-stage operation (p. 78 of his book) for a wide and incomplete cleft. Although this is perhaps the most difficult cleft to close, I have done either Lane's operation as I shall presently describe it, or Langenbeck's method, and I might feel tempted to try the method of Griffiths just mentioned. I propose, therefore, to describe how I perform Lane's operation, and would like to warn intending operators by Lane's methods that what is easy in his hands may be impossible to those less experienced ; that for success they may need a wider flap than Lane would require ; and that strict attention to detail is as essential in this operation as in Langenbeck's, or indeed in a plastic operation performed for any purpose whatsoever.

It is desirable of course to avoid scarring as much as possible, by cutting flaps as narrow as is consistent with a proper overlap. The beginner is advised to err on the side of cutting too large flaps, the chances of successful union being

thereby enhanced. He must bear in mind the three areas I have mentioned on the palatal surface of the two segments of the upper jaw, and note carefully to which side, if at all, the septum is attached : for the reflected flap must be hinged where the septum is not attached. Let me assume that the cleft is complete and the septum attached to the left side of the cleft. I use a Lane's gag with teeth to prevent its slipping. It is more convenient to use a single gag placed on the left side, but two may be employed if preferred. Most of the bleeding can be stopped by direct sponge pressure, occasionally Lane's pressure forceps are required. Finger-shaped pieces of marine sponge form perhaps the best swabs, but pieces of gauze similarly shaped do very well. In clearing the nasopharynx of blood, it is best to pass the swab along the dorsum of the tongue

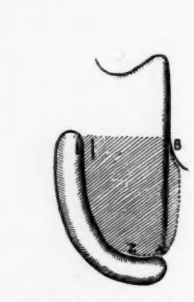


FIG. 171.—Shaded portion, undermined area.

FIG. 172.

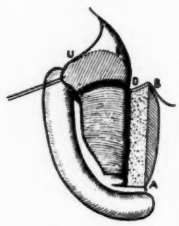


FIG. 173.

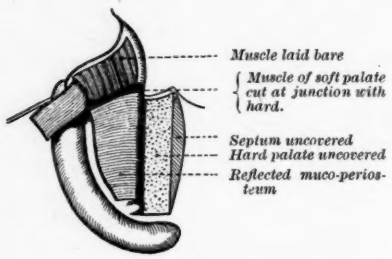


FIG. 174.

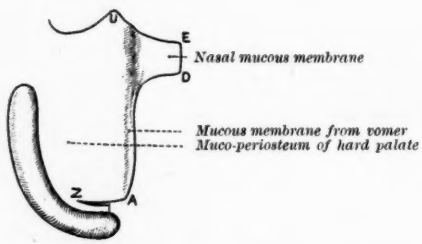


FIG. 175.

FIGS. 171–175.—LEFT SIDE OF CLEFT. Author's method of performing Lane's operation.
A B, Preliminary incision ; A Z, additional incision L (*Fig.* 171), Berry's lateral puncture ; U, uvula.

to a point on the posterior pharyngeal wall opposite the epiglottis, and to withdraw it by sweeping it along the cleft towards the front of the mouth. The patient having been anæsthetized, the shoulders are raised, the head is thrown back, and the operator seats himself at the head of the table on a high stool, the patient's head resting almost on his knees, and the anæsthetist being on his left. The position of the neck must not be exaggerated, as breathing may be impeded, but the nasopharynx should be the lowest point, so that the blood may not reach the glottis. A suture is then passed through the anterior part of the tongue, the ends clamped between the blades of a pair of Spencer Wells' forceps which are given to an assistant to hold. Moderate traction is required, with occasional variations in tension to suit the breathing, and in direction to suit the operator. Anæsthesia is then continued through a Junker's inhaler

with a metal mouthpiece which lies just within the left side of the mouth, not projecting into the nasopharynx. The gag is then readjusted so as to get the best exposure of the cleft. If the surgeon hopes that he may, after all, be able to do Langenbeck's method, he should attack the left side first, as the early stages of the operation, apart from the lateral incision, are, as I perform it, the same. A small lateral puncture just to the inner side of the first molar tooth is permissible to assist separation of the muco-periosteum, but is not essential. An incision is made along the margin of the cleft, or better upon the surface of the attached vomer throughout its whole length, and the mucous membrane, which is here extremely thin, raised from the bone (A B, *Figs.* 171–175). By means of Lane's special knife, or a slightly-curved and thin raspatory which is almost sharp, the separation is continued until the thick intermediate area previously described is reached. Separation at this stage and later is greatly facilitated by a short additional incision just to the inner side of the incisor teeth. The separation may then be continued outwards with little fear of doing damage, using the instruments mentioned. Mr. Berry's method, with a slightly-curved aneurysm needle, is of great assistance, using if necessary the short lateral puncture. Separation of the muscle of the soft palate from the back of the hard is the next step. A suture should be passed through the uvula on the left side, and the soft palate drawn forward to indicate the junction. The incision on the septum is then carried on to the nasal surface of the palate to reach this point (B D, *Fig.* 172). The aneurysm needle is next insinuated at the junction of the bone and muco-periosteum, and free separation completed as far back as possible, and as far out as the teeth. Scissors (one may use Mr. Berry's, but I have found a very fine sharp-pointed pair of straight ones satisfactory) are then placed, one blade between the muco-periosteum and the bone, the other in the nasopharynx, and the attachment of the soft palate to the bone cut through a little at a time. It is then ascertained that all the necessary separation has been obtained, and the operator finally decides, if he has not already done so, by pulling the flap towards the middle line, whether with a lateral incision Langenbeck's operation is advisable. A lateral incision through the mucous membrane of the soft palate on the junction of the palatal and the lateral pharyngeal wall of the *nasopharynx* greatly assists adduction of the flaps, and may be done if it does not penetrate the muscle, in either operation. Should Lane's method be adhered to, the mucous membrane must be carefully dissected off from the muscle of the soft palate towards the middle line, beginning along the line D E U (*Fig.* 173), ending at the uvula, with a sharp knife, an old, fine, worn-down scalpel being the best. The appearance of the separated flap is shown in the diagrams. Separation of the other side may then be begun. If the plan of operation has been decided upon from the start, it is better to work alternately on the two sides of the cleft, keeping pressure upon the side which for the time being is not being treated.

Turning next to the right side of the cleft, an incision is made along the alveolar border, if possible on the inner side of the teeth (along M N, *Figs.* 176–179). These incisions should be carried right down to the bone, and pressure applied at once to check the bleeding, which will be free. The periosteal elevator is introduced, and separation begun towards the margin of the cleft. If the operator is new to the method, or if the cleft begins to widen appreciably at the junction of

the hard and soft palate, the incision M N should be carried across the unerupted first molar, or behind it if it is cut, to the outer side of the alveolus along the line N O. With a sharp knife, the incision on the soft palate should be marked out, running directly backwards along O P, to the anterior pillar of the fauces. It must then be carried directly inwards, skirting the tonsil, and, passing along the posterior limit of the soft palate, reach the uvula at Q. The mucous membrane of the soft palate is then grasped with forceps at the point P, and carefully raised with its subjacent submucous tissues from the surface of the muscle. This is a part of the work which requires the greatest care and skill, and I have found it difficult to avoid damaging the muscle, especially at the junction of the hard and soft palates, where the surface is concave towards the mouth and the mucous membrane is very difficult to separate. One can free it as a rule fairly safely about as far as the line O Q. It is then best to complete the separation of the muco-periosteum of the soft palate from the front, taking great care, when the " marginal area " is reached, not to separate to the extreme edge of the cleft. It should be carried as far back as possible with the elevator or

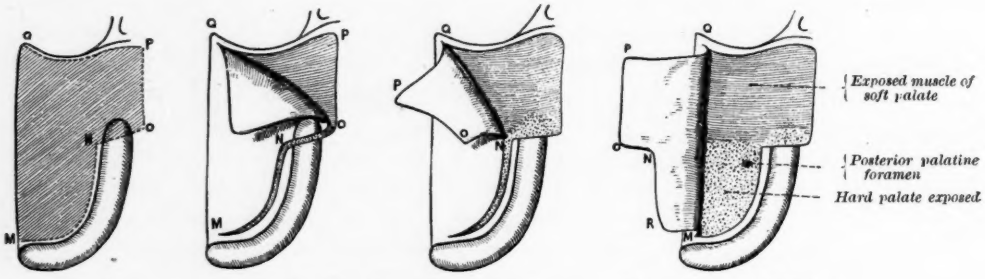


FIG. 176. FIGS. 177, 178.—Separation of mucous membrane over soft palate. FIG. 179.—Flap reflected.

FIGS. 176–179.—RIGHT SIDE OF CLEFT. Shaded portions show area of separation. M N O P Q, lines of incision.

aneurysm needle to the junction of the hard and soft palates, and over and behind the molar tooth. When this has been done, the posterior palatine vessels as they run into the flap, require division. Finally, by gradual and patient dissection, first at one point and then at another, the flap is turned over ; the muco-periosteum of the hard palate being pushed rather than cut, by the finger covered with a piece of gauze. It should be seen that the mucous membrane is fully or almost fully reflected from the soft palate at its junction with the hard, otherwise the full available overlap will not be obtained ; but any error must be in the direction of leaving more than enough tissue at the margin to nourish the flap along its whole length. The flap should finally lie as in the diagrams, being hinged at M Q (*Fig.* 179). An inspection is made to see that the flaps lie satisfactorily in place, that all bleeding has stopped, and that the cavities are clear of blood. The anæsthesia, which previously should have been of the lightest, is maintained so as to avoid much movement during the period of suture, which needs careful attention.

For suture by this method (*Figs.* 180 to 183), I have been in the habit of using fine silk with a small curved needle tied to each end ; curved

advancement needles with split eyes are very convenient, and need no knot. Either Lane's needle-holder may be used or a narrow-bladed pair of Spencer Wells' forceps. Particular attention should be paid to the posterior end of the soft palate, and a good result depends largely on the care with which the soft palate is sutured. Deep sutures are passed

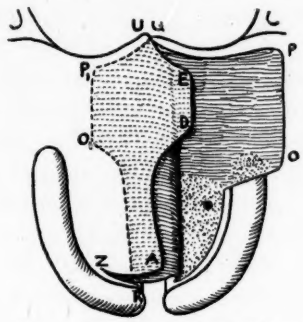


FIG. 180.—Flaps in position for suture.

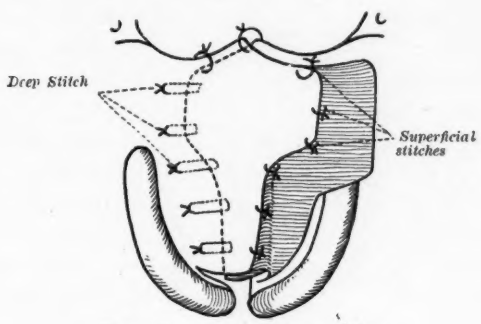


FIG. 181.—Sutures in position.

FIG. 182.—Section through hard palate. *a*, deep stitch *b*, superficial stitch.

FIG. 183.—Section through soft palate.

through the margin of the reflected flap, from the raw side, through the mucous-membrane-covered side, and back again to the raw side, to obtain a good grip of the tissues. They begin at the point Q, and are passed at intervals of about half an inch from the point Q to the point R. It is convenient to attach each end to a pair of forceps, and to leave them hanging over the right side of the mouth. At each end of the thread there is a needle, and these are brought through the left side of the palate from the nasal to the oral side, at the junction of the mucous membrane with the raw surface, as near to the outer margin of the palate as practicable. This pulls the reflected flap under the left-hand one, and obliterates the uncovered surfaces on the nasal side. The two ends of each suture emerge in the mouth close together and are drawn tight and tied, the back one first, and the rest from behind forwards. Sutures should also be put in, through the uvula at Q, beginning on the mucous surface of the right side, passing to the raw side; then through the uvula on the left side at the point U, passing from its raw to its covered side. An important stitch or series of stitches fixes the remaining overlapping part of the left side to the underlying posterior edge of the right side of the soft palate (i.e., stitch Q P to U E). A series of sutures then unites the

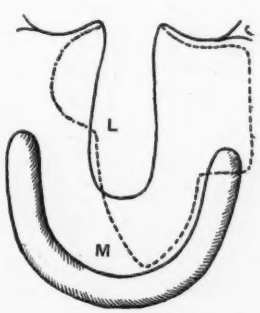


FIG. 184.—Incision for incomplete cleft.

remaining overlapping mucous membrane to the underlying structures. The final appearance, and the position of the sutures, are indicated in the diagram. If the cleft be incomplete (*Fig.* 184), the first incision may be along the line L M in *Fig.* 184, the aneurysm needle or elevator being introduced and worked towards the left, so as to start the separation of the muco-periosteum of the left side, the rest of the process being as before.

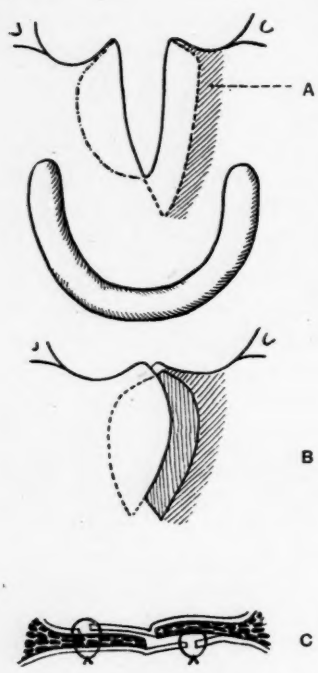


FIG. 185.—Lane's operation for a narrow cleft.

For a small or very narrow cleft, narrow flaps may be made and the whole of the raw surface closed in by slight undercutting of the mucous membrane of the right side of the soft palate (*Fig.* 185, A), to the outer side of the original incision. *Fig.* 185, B shows the flaps separated and in place; C is a section showing the undercut right mucous membrane.

Langenbeck's Operation.—This is adopted as the standard by nearly all English operators of note. In the hands of Sir Thomas Smith and of Mr. William Rose, such results were attained that it is not surprising the method became popular; and when we consider the excellence of the results obtained now by Mr. James Berry, Mr. Murray, of Liverpool, Mr. Kellock, and others too numerous to mention, it would almost seem presumption to perform any other operation. And yet I am inclined to doubt whether there are many men who could produce a consecutive record like Mr. Berry's, since in spite of the excellent descriptions in the text-books, the principles of the operation do not seem to be generally grasped. It seems also, that a special interest, and perhaps a special capability, is required to make an otherwise excellent surgeon into a successful operator in cases of cleft palate. Certainly experience, not of surgery in general, but of these operations in particular, is essential, and perhaps so much material being absorbed by the few, the many have not the opportunity, and consequently not always the interest, to perfect themselves in this branch of work. Many "improvements" have been introduced into the operation, but those which have survived have all been rather simplifications than elaborations of the original method. Most of them have been designed to abolish tension in the sutured edges; but the more experience a man gets, the smaller do his lateral incisions seem to become; he gets rid of tension in other ways. But let the beginner try to avoid long lateral cuts, and his sutured clefts will not long remain closed. I mention this to show the importance of practice: a surgeon may give up the operation before he gets past the stage of frequent failures, and certain eminent operators have advised that he should do so and leave cleft-palate surgery to those who can already do it. In view of the full descriptions in most of the text-books, it seems unnecessary to give a complete account of the operation. Mr. Berry's book will remain the standard, and rightly so, for many years to come. Moreover, much of what I have said

regarding one side of the cleft in Lane's operation applies also to this. Each stage of the operation is distinct, and has its own special difficulties, which will be discussed seriatim. These stages are as follows :—

(1) *Detachment of the muco-periosteal tissues of the palate from the oral surface of the bony palate ;* (2) *Detachment of the soft palate from the posterior edge of the palate bones* ; (3) *Paring the margins of the cleft ;* (4) *Suturing the pared edges ;* (5) *Making, if necessary, lateral incisions to relieve tension.*

1. The method described above is useful for this stage. Since lateral incisions will have probably to be made later, it is often worth while to make lateral punctures from the first. Time is thereby saved, as it renders the separation much easier to work from the edge to the centre of the cleft. The aneurysm needle is made to appear in the cleft, and the separation of the margins is begun from that point. It is often possible, as Berry shows, to do almost the whole of the necessary separation for both sides through a single incision placed in the most favourable situation. It seems curious that there are a few surgeons who appear unaware that this separation is an integral part of the operation.

2. Incomplete separation of the soft palate from the palate bone is perhaps the commonest cause of failure. Owing to the pull of the muscles this is always a weak spot in the operation, and if the separation is incomplete, tension is inevitable. Most operators use some form of Mr. Berry's scissors, but the ideal instrument has not yet been invented. After this has been done, the soft tissues of both hard and soft palates should then, if the head be raised, hang down " like a pair of curtains."

3. With most operators, I believe it is best to defer paring the edges of the cleft till the separation is complete. A narrow sharp knife is required. The paring should be economical, but sufficient should be removed to ensure a wide raw surface of contact. Instead of paring, Binnie advises splitting of the flaps along their margin.[27] He claims that a broad attachment is obtained without loss of tissue. Or very narrow flaps of the Lane type may be employed. This is of course anathema to the orthodox, but it has helped me to get union in a case where a previous Langenbeck's operation had been unsuccessful. The remainder of the operation was strictly orthodox, down to the lateral incisions (*Case* 38, *Fig* 153). Berry says that if approximation of the flaps is incomplete, partial division of the tensor palati and palato-pharyngeus, close to the soft palate on the nasal side, may be required.

4. I prefer silkworm-gut to wire, and use Lane's needle-holder and needles. It is important to see that the sutures pass completely through the palate, taking a wider grip on the nasal than on the oral surface. Great care should be taken that the mucous membrane is everted so that the raw surfaces are in complete apposition. To ensure this, Mr. Murray frequently employs button sutures. A mattress suture or two in the hard palate, put in close to the edge of the cleft, is a useful addition to the other stitches. Mr. Sinclair Kirk[29] uses a continuous suture ; I have not tried it, but it has given a good result in a case done by one of my colleagues. The uvula should not be strangled by a suture placed completely round it, and the other sutures should not be too tightly tied, especially in the hard palate. If a palate has nothing else to depend on for union but the tension of its stitches, I am convinced that it will break down. I am informed that Sir William Macewen tickles the roof of the

mouth three times a day for a fortnight before he performs an operation for cleft palate, in order to accustom the child to the presence of the stitches.

5. Upon the question of making lateral incisions, there appears to be more difference of opinion than upon any other of the vexed questions on this subject; for unless tension is abolished, the palate will not hold. And it is upon this very point that the instructions in the books are most nebulous. We all know that in the hard palate, they must go down to the bone, because for the separation of the muco-periosteum of the hard palate, the method practically demands it. As to the length of the incisions, most surgeons are agreed: they must be as short as is compatible with the abolition of tension. Proper separation of the soft palate greatly diminishes the need of a long lateral incision. They must not be too far forward, nor too near the middle line. It is a fairly safe rule that the incisions should be carried as far back as midway between the posterior border of the hard palate and the anterior pillar of the fauces. Most surgeons will say that this is too far back; but the tension always seems to come in the soft palate. Berry recommends that the incision should slope outwards behind the alveolar margin, but even he says nothing as to the *depth* to which the incision in the soft palate should be made. Mr. Owen, on the one hand, says that division of the tensor and levator palati through the lateral incisions is generally necessary, and denies the statement of Brophy that it is ever permanently harmful. All surgeons, I believe, have given up Fergusson's method of dividing the levator palati, and of any bony division in this region.[30] On the other hand, Binnie[27] says that all incisions dividing muscle are inadmissible. All authorities are agreed that division of the muscles must be avoided where possible. A good deal of tension can be got rid of by a simple division of the mucous membrane of the soft palate in a line with the lateral incision of the hard, and with the help of other methods I believe that an experienced operator by this method has no need to divide the muscle. I cannot speak with any great authority on this point, but my own experience makes me decide in this way. To obviate this necessity many surgeons, notably the American and Canadian, make use of waxed tapes and metal splints surrounding the flaps in the hard palate. Mr. Murray employs the same method frequently, and also gets rid of tension by means of button sutures. Mr. Berry occasionally uses leaden plates and silver wires to get rid of tension farther back, but it is noticeable how his increasing experience has led him to discard such aids, to shorten his lateral incisions, especially in front, and to rely more and more on stout relaxation sutures, passed some three-fifths of an inch from the cleft and tied only moderately tightly.

No other method of operation needs detailed description here. Few have survived for any length of time. Fergusson's osteoplastic method is unheard of now. It is true that Mr. Brophy has a method for older children which involves drilling the hard palate, and the use of silver wire sutures to maintain the apposition of the margins of the cleft; but though his results are said to be satisfactory, we have no statistics of them, and I am not aware that the method is used much apart from its author.[27]

Preliminary and Secondary Operations.—From what has already been said, it will be obvious that whether the operation on the palate be done in infancy or not, a harelip, if complete, should be closed as soon as possible. We may recapitulate the reasons:—

1. Simultaneous operation on the lip and palate is inadvisable on account of the extra time necessary for their adequate performance.

2. Early or even relatively late closure of the lip, approximates the cleft alveolar margins completely or sufficiently in a few months to make closure of the cleft practicable in the period of infancy, if it seems desirable to operate during that period.

3. It makes such closure of the cleft much easier, and much less expensive in the use of the coverings of the teeth.

4. It does not hamper the operator when he attacks the palate.

5. It has a very good effect on the nutrition of the child.

Therefore, *early operation on the lip is advisable* in the following cases at least, unless the nutrition of the child forbids it :—

1. In all cases of tripartite palate.

2. In all cases of bipartite palate where the lip is completely cleft, in order to approximate the alveolar margins.

It is not so urgently necessary in the bipartite cleft if the harelip is incomplete, because there will be no projection of the jaw on either side ; nor is it essential if the cleft be incomplete, because closure of the lip *per se*, does not seem to have much effect in diminishing the width of an incomplete cleft ; still, it should be done :

3. In all cases where " early " operation on the palate is not indicated.

There is no objection to its performance in the remaining cases, and other things being equal, it is perhaps advisable on account of the improvement in nutrition ; but the majority of surgeons will agree that the older the child, and hence the less small the tissues of the lip, the prettier will be the final result of the harelip operation.

Bone Operations on the Premaxilla.—Mention has been made, and instances given, of the unsightly forward projection of the premaxilla in complete clefts. Many surgeons have endeavoured to reduce the projection by operations upon the premaxilla or nasal septum in tripartite palates, and upon the premaxillary side of the cleft in bipartite cases.

Personally, I have not found it necessary to do any operation upon the bone in a *bipartite cleft.* So long as free undercutting of the mucous membrane and the muscles attached to the jaw on the same side of the cleft is employed, and the ala of the nose be freed fully, including its attachment within the nostril, not much difficulty is experienced in getting union without excessive tension. Mr. Berry's, or a similar stitch, *within* the nostril is essential.

In the tripartite variety there is some difference of opinion. Dr. Hans Spitzy[23] says : " It is not advisable to unite the lip over a prominent bone, because it would easily give rise to a beak-like appearance of the upper lip, and, besides, imperil the safety of the suture. In the most pronounced cases it is certainly best to remove the prominent intermaxillary bone, and to use the skin flaps which correspond to the future philtrum to cover the septum, as proposed by Lorenz. Owing to the removal of the intermaxillary bone, the upper lip certainly will look unpleasantly flat and depressed, but this defect can be remedied by a dental bridge. At all events the practical result is better, and the bridge teeth can be better used for mastication than those growing in the intermaxillary bone, which is lacking in firmness or has been loosened by attempts at reposition ;

besides, these teeth rarely occupy a correct position. Other authors (Bardeleben, Blandin, Partsch) suggested a cuneiform excision from the vomer, or linear intersection, and retroposition of the vomer in such a way that the parts of the vomer will be shifted alongside each other. It has also been tried in an orthopædic way to effect a retrodisplacement of the intermaxillary bone before closing the cleft (Thiersch, Simon). This will not create normal conditions, because the intermaxillary and superior maxillary bones will not unite, with the result that the teeth are defective both in position and direction. In cases of considerable deformity with protruding intermaxillary bone, I consider the method of Lorenz advisable; lighter degrees correct themselves by the closed lip."

Some surgeons turn out the teeth from their sockets in order to diminish the size of the projecting intermaxilla. Berry says that "complete removal leads to approximation of the maxillæ, and causes the alveolar arch to assume subsequently a narrow angular form which interferes with correct articulation, and causes pronounced mal-occlusion of the teeth." If the premaxillæ are very prominent, he removes a wedge-shaped piece of the cartilaginous septum from behind the projection.

We may, I think, dismiss the idea of turning out the teeth; the diminution of the premaxilla so obtained is insufficient to counterbalance their loss, and other methods are more satisfactory. Complete removal of the premaxilla is abhorrent to the conservative surgeon, and appears to offer no advantages, but to be open to many grave objections. If the lip can be safely united over the premaxilla, I think it is wise to do so; the difficulty is all a question of sufficiently free preliminary separation. The beak-like appearance will only be temporary if the operation is done early. If the prominence is as great as in *Fig.* 152 (*Case* 36 of my series) partial reposition at least is necessary. Berry says truly that it is neither possible nor desirable to effect complete reposition. Removal of a wedge is best performed by separation of the soft parts with the perichondrium from the cartilage, a little behind the premaxilla, the cartilage alone being removed, leaving the soft parts. Pressure backwards then secures reposition. Fixation of the replaced bone apart from closure of the lip may be tried, but it is rarely successful. Strapping may be applied across the gap, or closure of the lip proceeded with. In the few cases I have had to deal with, I have employed a two-stage operation of my own for the harelip. The removal of a wedge is bound to result in some degree of tilting of the segment (*Fig.* 186), which is another reason for avoiding operations for replacement, particularly of this class. To prevent this, in Case 36, where the septum appeared to bend downwards at its anterior extremity, after separating the periosteum and soft tissue through an incision in the middle line of the vomer upwards and anteriorly above the premaxilla towards the tip of the nose (a manœuvre which was not effected entirely without perforation of the mucous membrane), I divided the septum almost parallel with its lower border. Replacement by pressure gave an

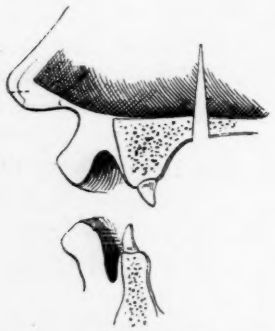


FIG. 186.—Showing the tilting of upper teeth when wedge is removed

almost prominent bridge to the nose, and though eruption of the teeth has not yet taken place, the segment, now that both sides of the lip are closed, seems to be in place without tilting. The idea of this method may not be new, but I can find no record of an exactly similar operation. The diagrams (*Figs.* 187, 188) show the method employed.

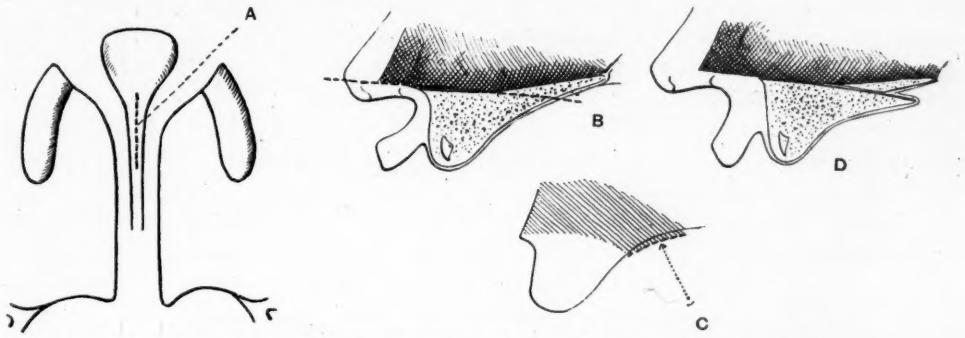


FIG. 187.—AUTHOR'S SLIDING OPERATION FOR THE REPOSITION OF PREMAXILLA.

A, Preliminary incision. Separation of nasal mucous membrane from septum from behind forward to tip of nose, as in Killian's operation. Snip cartilage from behind forwards, not including skin, and slide or press premaxilla back. B, Line of oblique incision; C, Incision and separation of mucous membrane on each side of septum from behind forwards; D, Final position of premaxilla.

Secondary Operations.

Complete failure after Lane's operation,—If such should result, no further attempt should be made to close the cleft until at least two months have elapsed. If the suturing has merely given way, secondary suture may be tried, since union of opposed large surfaces may take place by granulation. Wolff,[31] of Berlin, deliberately invites this process by stitching the flaps a week after he has cut them. But if the sutures give way, the technique of the operation is wrong, for the flaps will almost lie in position without sutures, though there is a tendency for the reflected flap to return to its normal position. In cases of complete failure this is what usually occurs, and there is rapid healing. The failure of a previous operation does not seem to prejudice the success of another unless the first has been very carelessly performed. Complete failure is rare even in inexperienced hands if the important points previously insisted upon are borne in mind.

FIG. 188.—Normal eruption of teeth after author's sliding operation.

Complete failure after Langenbeck's operation is not so rare as many writers would have us believe. It is rare in the hands of the best exponents of the method, who are inclined to believe that all surgeons are equally gifted. As in Lane's operation, failure is chiefly due to want of full understanding of the principles involved, and of the mechanical possibilities of the method. If complete failure occurs, and the cleft is really closable (which may be discovered by the methods I have indicated), a second operation should not be delayed too long, certainly not more than a month; otherwise the muco-periosteum will

become so adherent to the bone that it is difficult to separate it again without risk of injury. Mr. Berry is very strong upon this point, and I can thoroughly endorse his statements on it. In my opinion, secondary suture at the end of a week is hopeless. It is true that Mr. Owen succeeded on one occasion in closing a cleft in this way, but a granulating edge, especially one that will not keep still, has little chance of union by its narrow surface with its fellow. Infection of the new stitch holes is also almost certain, and union by first intention is a *sine qua non* in Langenbeck's method. Again, when a late colleague of mine was trying to immunize cases of cleft palate to a staphylococcus, we more than once found that, though the opsonic index to that organism was high, the cleft broke down owing to a streptococcal infection, and neither hetero- or auto-immunization could be relied on.

Partial failures after Langenbeck's operation.—They occur most commonly at the junction of the hard and soft palates, and appear to be due to imperfect separation of the muscle from the bone. I have had them a little farther back, at what I believe to be a point of inevitably greater tension. Mr. Berry says that if the soft palate be united behind the hole, closure will not be difficult and may be spontaneous. He therefore waits longer than if the whole cleft had broken down. Minute holes should always be given a chance to close spontaneously; if this does not finally occur, a thermo-cautery may be passed into the opening, when destruction of the epithelium may result in the closure of the cleft. Mr. Berry does not advise the closure of large anterior holes as a rule. The farther forward they are the more chance is there of spontaneous closure, and a light obturator covering the opening may be worn either temporarily or permanently. Should closure be necessary or advisable, he performs not Lane's operation but a "modification of the late Mr. Davies-Colley's." This, to my mind, is a distinction without a difference.

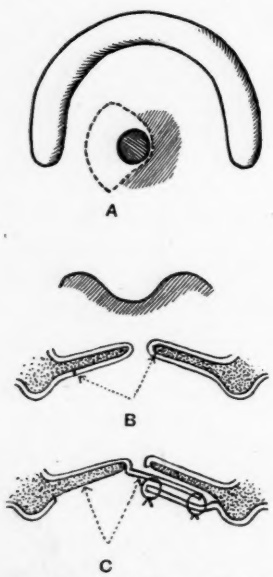


FIG. 189.—Closure of holes left after operation.

A, Dotted line shows incision. Shaded lines undermined periosteum. B, Incision. C, Raw surface.

Partial failures after Lane's operation.—In these cases at least two months should elapse before again tackling them. Minute holes should be left to nature, or the cautery applied. Larger ones are of two kinds: preventable and inevitable. The latter are either deliberately left to be dealt with at a later period —as, for instance, the opening between the closed harelip and the anterior end of the reflected flap in a complete cleft; or they may result from the difference in level of the anterior end of the cleft and the reflected flap. The preventable holes are usually the result of reflecting the flap from the wrong side of the cleft, i.e., the side attached to the septum; or of separating this flap along the marginal area of the palate too close to the edge of the cleft, and buttonholing or completely detaching it anteriorly. After waiting for a suitable length of time they can be closed in the manner described in the annexed diagrams (*Fig.* 189).

THE RESULTS OF OPERATIVE TREATMENT.

Elimination of Brophy's and Griffiths' Operations.—Reduction of the width of the cleft by clamps, such as have been used by Ulrich[8] and Spitzy,[23] and already given up by the former, are open to greater objections than Brophy's more gentle operation, so that we need not consider them separately. We have already shown that Brophy's fundamental assumption is unsound, so that complete closure by compression is neither wise nor right. If partial closure is all that is aimed at, it can be obtained in a comparatively short time by the less dangerous and simpler expedient of closing the lip. Brophy's operation is not applicable to incomplete clefts, and it is doubtful whether, in the complete ones, it brings the posterior ends of the cleft into apposition. In most cases, too, a second operation on the lines of a Langenbeck is required, so that the immediate object is not gained. Brophy has done 211 operations on infants less than six months old, without a death, and yet in less skilled hands the mortality has been dangerously high. It is the old story of the inevitable difference in the capacities of operators, of the absolute necessity of a full knowledge of technique, and still more of a full and sympathetic understanding of infants, their behaviour under operations, and their capacities for undergoing these serious ordeals. Sympathetic, interested, and intelligent nursing is another necessity. Where all these factors are present at once, which can only be where such operations are done frequently, the risks are reduced to an absolute minimum; where they cannot be obtained, I feel strongly that no surgeon should allow himself to be tempted to perform Brophy's operation. A large number of those who have tried the method say that they cannot get approximation without tilting of the bones. We are assured that this will not take place if the wires are correctly placed. I should not myself venture on the operation unless I could have a personal demonstration from Mr. Brophy. Mr. Berry has pointed out how very little room there is in the infant between the orbit and the unerupted teeth, and Brophy himself admits that the teeth sometimes erupt irregularly and show other signs of having been injured by the operation. In less skilled hands this would be certain to occur more frequently. We have shown also that damage to the teeth may also cause mal-development of the antrum, and so result in impairment in the timbre of the voice. As to the possibility of a contracted palate following this operation, Brophy[32] says that the alveolar process develops with the eruption of the teeth, and that in due course the teeth of the upper jaw will be found antagonizing those of the lower jaw in a normal way. Owen adds that "even if this were not so, the defect would be more than counterbalanced by the fact that, owing to the approximation of the hinder ends of the maxillary processes, the surgeon had been enabled to form a soft palate without the occurrence of tension, and without interfering in any way with the palatine attachments of the tensor palati and the levator palati." This means, that not only are lateral incisions unnecessary, but also in all probability separation of the muscular soft palate from the hard may be omitted. If that is so, it is of course a great gain, but judging from what I have read and been told, it is comparatively rare to get sufficient approximation posteriorly to render these safeguards needless. One may also question another of Brophy's claims; he says that there is less nervous shock in the first few weeks than

when the baby is older. It is not clear what he means by this; but if he claims that it stands the operation better, this seems doubtful. I shall return to the point when speaking of nutrition in trying to estimate the value of Lane's claims. He says also, that the muscles of the palate are given an opportunity to develop instead of to atrophy, and the patient does not get into the habit of articulating into the cavern of the nose. The first part of the statement is no doubt true, and must be a valuable asset to the survivors, but we know from published statistics neither the immediate nor the remote mortality of the operation. In Brophy's own hands the immediate mortality is " about 3 per cent," but we know nothing as to the fate of the survivors; some of them may die early. In other hands, as far as we know, the death rate is nearer 40 per cent than 3 per cent. As to the latter statement, it may be true; all we can say is that we do not know. There are no figures. If it were true, and the mortality not excessive, the operation would be one that no surgeon could have an excuse for not learning. But as it is, the lack of justifying statistics, rather than any theoretical objections, insists that we shall, at present, follow more established methods.

I have included Mr. Griffiths' method, because it is an important link between the early and the late operation. I am not certain that all his assumptions are correct. Most operators caution us, in Langenbeck's operation, not to make our lateral incisions too long, especially in front, for fear of necrosis; and Griffiths' operation makes them complete anteriorly. In Lane's operation, as already pointed out, if the flaps are improperly cut, there is a danger of necrosis at the extreme tip. I cannot feel certain that this does not also occur to Griffiths. And even if it does not happen, the flaps are liable to shrink, and so to leave a hole anteriorly larger than they should. The main reason for dismissing this method is, that here again there are no facts to back it up. When it is shown that early operation gives a better chance of perfect speech than if done later, then only will this and similar operations receive the attention they deserve.

Advantages and Disadvantages of Langenbeck's and Lane's Operations.—In the early part of this paper we limited ourselves to anatomical considerations. We cleared the ground, as it were, for the full consideration of the question, discarding as far as possible all bias. We next mentioned certain methods of operation, and discussed their limitations. We have on certain grounds excluded compression methods and Griffiths' method; we are left with Lane and Langenbeck. We have eliminated from Lane's devices all but two varieties—a proceeding which may preclude operation in the first few weeks or even months of life—and we have decided to close the harelip first, in most, if not in all cases. We have hitherto left Langenbeck's operation unattacked, though we have demonstrated that it is usually impracticable in infancy. We are left with a period of life extending from say, three months to about three years, during which we can usually do one operation only, namely Lane's, and a further period from three years onwards when we can do either method. We are now, therefore, in a position to consider the merits and demerits of the two methods. It will be seen that this also involves the discussion of the age at which operation should be performed, as the two questions are well-nigh inseparable. Enough has been

said to indicate my belief that excellent as an operation may appear to its performer, reasons in its favour must have the support first of anatomical fact, and secondly and finally, in the minds of the unbiassed, of reliable and verifiable evidence. As Lane's operation claims to be an improvement on the already well-established method of Langenbeck, we will consider its claims first. They are as follows :—

As regards Early Operation.—The advantages claimed for this are:

(*a*). *That it is a life-saving procedure.*—This can no longer be held. Certain cases awaiting admission to hospital for early operation die before they can be admitted, but this is no proof that immediate operation would have saved them. It has been said that immediate operation prevents improper and ineffectual feeding, and so saves life. It is not the operation but the nursing that prevents death, and feeding is a matter which has to be attended to whether the infant is operated on or not. I have had these cases under my care almost from the day of their birth, and have too much difficulty in accustoming them to their new and unnatural mode of receiving nourishment to be anxious to subject them to a further ordeal. Though they may be healthy at birth, feeding difficulties are quite enough handicap for them. I prefer to let them get a firm grasp on life, and hold no brief for immediate operation. Of course, with the skilled nursing we get in hospitals, the thing can be done, and the child apparently be none the worse for the operation, but such a success only shows the perfection to which nursing has been brought, and does not justify the risk. It may be said that the subsequent feeding is easier ; undoubtedly that is so, but I have not come across the infant which could be taught to suck after operation. The feeding, which still has to be done with the spoon, is almost as lengthy and tedious as before. The parents can be taught to do it, and the children gain weight normally, but operation does not make the child independent of expert assistance for a single mouthful until he can use a spoon for himself. Until the immediate, plus the remote, mortality of the early operation can be shown to be less than the total mortality amongst cleft-palate infants during the first year, the life-saving contention cannot be maintained. It might be justifiable to deduct from the former percentages those deaths which could be proved to have no immediate or remote connection with operation, but not as Mr. Barrington-Ward[33] has done, to deduct what he believes to be the normal death-rate in cleft palate. Until these figures can be accurately arrived at, we cannot claim operation as a life-saving process.

(*b*). *That it results in an immediate improvement in nutrition.*—There can be no doubt as to the truth of this. None of my cases has lost more than a few ounces in weight as a result of early operation, and the subsequent increase has in many cases been astonishing. The argument as to improved nutrition is not very strong. It cannot be proved that the increase in weight would not have occurred in any case.

(*c*). *That on theoretical grounds, the earlier the malformation is corrected the greater chance is there of a proper development of the nasal cavities, the establishment of proper breathing, and later of proper speech.*—We must of course admit this without reserve, and I have already attempted to establish it in the earlier parts of this paper. But it has to be proved that the operation does not cause sufficient damage to prevent the possibility of these desirable factors having full sway.

I have had one case of cleft of the soft and part of the hard palate, the remainder of which was very highly arched (*Case* 18), in which descent of the uncleft portion of the palatine arch followed closure of the cleft. I cannot produce at present any more convincing proof. The child is backward in talking, but it cannot be said that she shows any signs of cleft-palate speech.

(*d*). *That there is less liability to Eustachian and middle-ear infection.*[33]—This may be true, but the liability is still there (*Case* 14). I have found it to be at least as great as before operation.

(*e*). *That habits of faulty articulation are prevented, and that therefore the speech is likely to be better than after later operation.*—The establishment of this proposition is the whole justification for early operation. Unless figures to prove it are forthcoming, operation must be postponed to a period when we know what results we have a right to expect. It has been assumed that since operations in younger children have as a rule produced better results as regards speech than they have in older children, therefore operations in infancy would show still better results. It does not follow, and there are so many exceptions to the first statement that it is of no value as a basis for reasoning. We have already laid down the necessary factors for normal articulation, and found that they do not necessarily require the proper development of the nose, nasopharynx, or accessory cavities. They are: (1) Normal or nearly normal anatomical conditions of the palate, with a sufficiently long and movable soft palate; (2) Normal or extraordinary receptivity of teaching, or capacity for making the most of not quite normal anatomical mechanism. We have noted that some of Mr. Brophy's cases are said to have passed the test of reading aloud. We have no results of Mr. Lane's own cases. Few of my own are old enough to furnish statistics, but such as they are they are given in the next section. It might be supposed that statistics of Lane's operation in older cases might form a basis for comparison, but the second factor mentioned shows that apart from special training the possibility of perfect speech cannot be realized, and none of my older cases have had this advantage. There are other factors besides the possession of a complete hard and a movable soft palate, which modify the voice.[34] *Case* 10 is an adult patient with a soft palate cleft almost as far as its junction with the hard, whose speech is absolutely normal; but his soft palate is also normal in length. *Case* 14, referred to before, had an operation in infancy for a cleft of about the same extent. She never spoke well, but the palate was short. Again, an obturator which succeeds in supplying the deficiency in the short soft palate produces a better result than any other form of appliance.

(*f*). *That infants stand the operation well; that they are easy to nurse, and that they recover rapidly.*—I have found that this statement is true; especially for cases outside the first few weeks of life. The feeding, though still tedious, is less difficult than before, and the practice of carrying the infants about to prevent their crying is unnecessary after Lane's operation. The condition of the infants for the first thirty-six hours after operation is often serious, and they may require constant attention. For another week, as a rule, they are not well (with the flap operation, if wide, they may suffer from septic absorption); after this period, recovery is rapid. They remain in hospital for at least three weeks after operation.

Criticisms Attacking Early Operation apart from the Method.—

(*a*). *The immediate mortality is too high to make the operation justifiable, especially as that of the later operation is, in the best hands, Nil.* The results of Sir Arbuthnot Lane's hospital cases seem to be such as to justify this statement.[33] It is claimed that many of the deaths would have occurred in any case, but it is doubtful how far this plea is a fair one. Out of twenty-five infants I have seen with cleft palate, one was not able to be nursed up to a standard of nutrition high enough to justify operation, and it died about a month after leaving hospital, where it was maintaining, though not greatly gaining, weight. This works out as a 4 per cent mortality, but the figures are too small to be reliable. It is possible, of course, that for patients not under observation the mortality would be higher still. In view of Mr. Brophy's consecutive series of 211 operations without a death, early operation in his hands is relatively safe. While House Surgeon at Great Ormond Street, one death occurred in about 100 cases; this death, though closely following operation, and doubtless due to it, could not be directly traced to it. The number of my own cleft-palate operations in infants has been only twenty-five. One case died; it was only my fourth cleft-palate operation, and occurred a month after an operation during a hot season, from dilatation of the stomach due to improper feeding; the child (*Case* 5) was six weeks of age, and did not vomit once up to the day of its death. This fatal event might have been avoided if the condition had been recognized. This gives a mortality of 4 per cent. If I include twenty-five more operations for harelip, done by the lengthy and rather complicated method I adopt, and in which the shock is about the same as in a Lane's palate operation, the mortality is 2 per cent; and I feel confident that by avoiding the first few weeks of life, and periods during which increase of weight is not being maintained, it can with increasing experience be reduced still further. In the last forty-five procedures there has been no mortality. Spitzy[23] had three deaths in 132 operations for harelip, only one of which he considered due to the operation. He says that from eighteen months to two years of age is the proper time for operation on the palate, and, speaking of harelip in which he performs the complicated and therefore lengthy operation of Hagedorn, that direct danger to life can be completely avoided by selection of the proper cases and the suitable time for operation. Applying these words to cleft palate, I am inclined to endorse his opinion.

(*b*). *The remote mortality is high.*[35]—I know of no statistics. I have lost one case (No. 3). This occurred from tuberculosis four months after operation. The father of this infant died from, and the mother had, active phthisis at the time the child was born. They lived in a single room. The child did well and gained weight for a month after operation, and it is hardly fair to attribute death to it. All the other cases are alive and well.

(*c*). *The operation is dangerous.*—There is truth in this, and it is not candid to deny it; but as I have said, increasing experience diminishes the risks, and if they can be made to approach the vanishing point, and *if early operation can be proved to give better results than the later*, the risk is justifiable. Until these proofs are produced it is not right to advocate early operation.

(*d*). *Early operation is not necessary, and has no compensating advantages.*—As far as published figures go, Mr. Berry has proved this contention.[1] Regarding the latter statement, we have at present no grounds for denying it.

Advantages and Disadvantages of the Later Operation apart from the Method.—Much of the ground has already been traversed, but may be recapitulated for the sake of clearness: (*a*) No proofs have been furnished of the superiority of the early operation; (*b*) There is neither danger nor mortality in the later operation; (*c*) The published results both look better and produce better functional results, especially if Langenbeck's operation be performed.

Personally, I find that one can as a rule produce a better-looking result if the operation be delayed, that is, providing it is not delayed for too many years, whether Lane's or Langenbeck's operation be performed. A small mistake on a tiny palate may do more damage than the same on a larger one. As to the published functional results, we have few or none for the early operation, and many and satisfactory ones for the later.

I have dealt with most of the objections to the later operation. One might of course say that the results as regards speech are on the whole bad; but one might fairly except Mr. Berry's, which are probably the finest ever published. Even in his cases only a small percentage were operated on at the time he considers the most favourable. In any event, subsequent teaching of the speech is required, a thing rarely obtainable.

Advantages of Langenbeck's Operation.—*If successful, it gives the best anatomical results.*—This, I think, can hardly be doubted. The teeth are never destroyed by the operation. Scarring of the *hard palate* seldom occurs, though not infrequently there is contraction at about the level of the bicuspid teeth after an extensive cleft has been closed; but this is likely to be present if no operation is performed (*Case* 47, *Fig.* 166), and is just as frequent in Lane's method. In the best hands, the soft palate is almost invariably mobile; this cannot always be said of Lane's operation. It is, however, liable to be short after the Langenbeck method, but that, I am inclined to think, is the penalty of a late operation. I do not know the depth to which Mr. Berry carries his lateral incisions in the soft palate, but not to any great depth as far as I can make out. Avoidance of deep incisions, to my mind, is the reason for the great mobility of his palates. Still, we have Mr. Owen's authority for the statement that deep incisions do not prejudice mobility.

The functional results appear to be influenced by two variants: the skill of the operator, and the possibility of training in speech. The choice of the most favourable time is as important as the manual dexterity of the surgeon. Good speech is almost the rule if the case has been in the hands of a small number of surgeons in the front rank. This shows the possibilities of the method. Repeated operations and poor speech are the more frequent lot of the less experienced and less expert, however skilled they may be in other branches of surgery. This shows the difficulties of the method. I do not wish to argue that better results would necessarily be got by Lane's method, for the man who cannot do one can hardly be expected to do the other; still, the average result as regards speech is not what it might be.

Disadvantages of Langenbeck's Operation—Can mainly be got rid of by proper understanding of the method, and of the best time to operate. But the problem of the abolition of tension, which is certainly solved by Lane's method, will always remain to baffle, at times, even the most expert. Understanding

the principles, the operation is easier than Lane's, but a good result is the product of an amount of judgment only to be acquired by experience. The age limits imposed by the principles of the operation will, if that is considered a disadvantage, always be a bar preventing early operations by this method.

Absolute asepsis is essential for a successful result. In the mouth we cannot guarantee it. Large holes of the hard palate are not easily closed by this method.

Advantages of Lane's Method.—*There is no age limit.* The operation, when performed with reasonable skill, is almost independent of sepsis and of post-operative mishaps. It is only fair to assert this. I have had failures, as have all surgeons, but not one that could not fairly be attributed to neglect of one of the cardinal principles I have mentioned, or to the choice of an unsuitable time for operation; never, I think, to the latter cause alone. Fortunately I have been able to retrieve nearly all by a subsequent operation on the same lines. The serious failures mostly occurred before I had fully grasped my methods. As to sepsis, it cannot be denied that where two large raw surfaces lie in apposition without tension, union by granulation is possible where edge-to-edge union is unlikely. The flap operation is strong where the median one is weak, namely, at the junction of the hard with the soft palate.

Objections to the Flap Method.—I have, I think, sufficient material to deal with these. It has been alleged that :—

The exposed temporary teeth are shed early.—Where the teeth on both sides of the cleft have been exposed, *Cases* 2 and 3 show that they have nearly all disappeared. This cannot be an advantage to the children, so that one must postpone the operation until the cleft can be closed without exposure of both sides. Where the teeth have been exposed on one side only, I have no case where they have been affected by the operation, whether all or only the back molars have been laid bare. Lateral incisors were absent in some cases, but this occurs so frequently in cleft palate that we cannot put it down to operation. Where the teeth have become carious, this has occurred as much on the uncovered as on the covered side. The importance of preserving these teeth is the prevention of forward movement of the unsupported first permanent molars and the subsequent crowding of the intervening ones. Since a slightly longer wait will result in the possibility of closure without exposure of any except perhaps the most posterior of the teeth, I prefer to wait rather than to risk injury to them.

The hard palate.—None of my cases has made it certain that *scarring* of this portion has been the cause of contraction of the width of the upper jaw, except in the above-mentioned two cases, where both sides of the gums were reflected. Such scarring is an additional reason for not operating too soon.

There is a likelihood of failure of union with necrosis of the jaw.—I have neither seen nor heard of this. Even in the cases where the operation has had to be repeated, there appears to have been no tendency in this direction. Healing has always been complete. Such a result is conceivable only if the child were too hopelessly marasmic to justify any operation.

The soft palate.—It has been said that the operation shortens this structure,

and that the hard is closed at the expense of the soft. I have explained how a median operation must shorten the soft palate. To the extent to which the soft palate is stretched, this must also occur in Lane's method, but since the stretching is less than in the median method, so also is the shortening. As to the latter point, if the cleft became narrower instead of wider behind, the soft palate might suffer in closing the hard, whereas it is possible actually to lengthen the soft palate by manipulation of the reflected flap.

The inevitable cicatrization of the raw surfaces produces a stiff immobile velum instead of a properly-formed movable soft palate.[36] Details regarding these points are given in the following table of results in nine completed cases, operated on by Lane's method sufficiently long ago to allow cicatrization to have its full effect. They refer to the condition of the soft palate.

Case	Age	Scarring	Mobility	Length	Other Details and Speech
20	Six weeks	Present	Slight	Short	Three operations have been done. Still too young to speak clearly.
17	Seven months	Very slight	Good	Good	Speaks well for age, $2\frac{3}{4}$ years.
15	Nine ,,	Slight	,,	Short	Cleft palate speech.
18	Seven ,,	Not obvious	,,	Good	Speaks well for age, 2 years, 7 months.
16	Ten ,,	,, ,,	,,	,,	Does not seem to have cleft palate speech.
14	Six years	Slight	,,	Short	Not good, no training.
8	Twenty-nine years	Present	Fair	,,	Not much improved, no training. Previous operation unsuccessful.
9	Twelve years	Slight	Good	? ,,	Speaks well, no training, soft palate not lax.
7	Sixteen ,,	Marked	One side only	,,	Speaks badly, no training, slight improvement.

Scarring has been marked as being present even when it has not been noticeable. It has been noticed in cases where the patient has been old, the tissues scanty, or the operation previously performed. Mobility has been interfered with in exactly the same class of case. In cases done at the period of choice, these ill-effects are not marked. In *Case* 7, a boy, aged 16, mobility of one side of the palate only was present, a condition said to occur frequently after this operation, although I have not found it to be so.

Before dealing with speech, we must notice the remaining objections brought against this method of operating.

It is said that the result is unsightly. Only rarely is the result really ugly, unless the operation has been done without due regard to the soft palate, but it probably never looks quite as well as a good Langenbeck.

It is said that these palates are often so thin that they look as if a pin thrust through them would cause the whole palate to burst like a bubble.[37] I think this should not occur. In *Case* 3 the soft palate is thin, but it is mobile. It is the result, not of an operation in infancy, but the final product of four operations, one performed by the median operation by another surgeon, and two unsuccessful attempts of my own. The tissue left was scanty and scarred. It has held for over three years.

It has been said that there is a tendency for the flaps to give way after the patient has been discharged as cured. The present condition of all my cases is known, and in the above-mentioned *Case* 3 a bridge of hard palate gave way over three years after closure, and the posterior end of the soft palate in *Case* 11 came apart more than a month after successful suture. The other cases are as they were left. I have also seen several cases in which this has occurred after Langenbeck's method.

The table just given points out that the anatomical perfection of the soft palate depends on the width of the gap to be dealt with, and the amount of material available. In relation to age, taken in conjunction with the other cases and the anatomical facts at our disposal, it seems to show that a good, long, and mobile soft palate cannot be expected from operation if the patient is much above eight years, nor, if the cleft is wide, much under six months. Nor can it be expected if the tissue has been much diminished or scarred by a previously unsuccessful operation.

These conclusions are of course exactly what one would expect. Apart from these limitations it appears as if an adequate soft palate can, and therefore should, be produced by this method. If a larger series of cases confirms this view, Lane's operation becomes justifiable from a mechanical standpoint.

Opinions of Authorities as to the Proper Time for Performing Langenbeck's Operation.—Mr. Berry, whose opinion on this method I regard as final, does not say in so many words the exact date at which he would choose to perform a cleft-palate operation. The reason for this silence is obvious. Nearly all palates differ, so that an age at which operation is right for one child, may be unsuitable for another. In addition, two cleft palates exactly alike anatomically and in children of exactly the same age, may be suitable for operation mechanically speaking, but the state of nutrition or the presence of sepsis may render operation inadmissible in one case but perfectly desirable in the other. But all things being equal, I think Mr. Berry would operate at the earliest possible period at which a Langenbeck's operation could be performed without damaging the soft palate to such a degree as to risk bad speech, i.e., if the palate were very wide and the patient young, he would prefer to wait until the palate could be closed without resorting to wide lateral incisions. In the majority of cases this favourable period is not reached before the third year, hence his choice of that age as the best average time for operation.

This method of making the time of operation subservient to the particular circumstances of the case, is of course the only rational way of dealing with the problem ; it is naturally applicable to other methods of operation as well as to Langenbeck's. Mr. Berry also believes that the results of Lane's operations are on the whole bad, so that his choice of a time for operation is limited by the possibilities of Langenbeck's method.

I give, in addition, the views of a Continental surgeon who performs this operation. Further multiplication of opinions would be reiteration. Dr. Spitzy, of Gratz, says [23] " If the operation has been successful, the palate will have a natural appearance. Deglutition will be facilitated, but speech generally remains defective. The velum being small and short, Passavant's ridge can be reached only with difficulty, even if the velum muscles have remained intact.

Gutzmann's linguistic exercises can now be commenced. Gutzmann has devised an elevator by which the velum can be raised, stretched, and massaged by the patient himself. The linguistic exercises are specially directed towards the normal pronunciation of the palatal sounds, and in many cases are attended with excellent results. In cases where the lower margin of the velum is separated too widely from the posterior faucial wall, a lateral incision of the palatal arches in order to mobilize the wall, or a paraffin injection to enlarge Passavant's ridge, will help to correct this condition.

"From this description it follows as a matter of course that it is in the interests of the patient to create normal conditions before the physiological development of speech commences, the need for normal use of the organs of speech being greatest at that period. For this reason I am unconditionally in favour of early operation, which means as early as the general condition of the child shall permit; not before the end of the first, and not, if possible, after the third year." Spitzy, therefore, appears to regard Langenbeck's operation as being feasible earlier than does Berry. It must be remembered that the latter's experience is much greater, so that if the elaborate procedures described above are frequently necessary after operation performed before the third year, I should judge that Mr. Berry is right, and an effective Langenbeck cannot often be done before that time. The anatomical principles previously mentioned also confirm this view.

The final test by which Lane's palates, however perfect anatomically, must stand or fall, is of course speech. We have to answer the following questions:—

1. *Is there evidence that Lane's operation gives results as good as does Langenbeck's, when both operations are performed at the same age?* Excepting recent ones, I have only four cases, none of which has had special training in speech, which, as I have shown, is a necessity in the late operation. Of these, *Cases* 7 and 8, aged 16 and 29 years, would not have talked well if Langenbeck's method had been done; *Case* 14, aged 6, has a short soft palate; there was much suppuration following operation, and he speaks badly. The parents have not devoted much time to him; he has a poor home, and is not very intelligent. *Case* 9, aged 12 years, is a bright and intelligent youth; his articulation is excellent when he speaks slowly; when he talks rapidly, one begins to realize that he has the cleft-palate voice; his speech is not explosive, but he has to make some effort to shut off his nasal from his oral cavity. On the strength of a single case one cannot claim an affirmative answer to the question, although the improvement in the more recent cases might induce a biassed person, such as the operator is bound to be, to assert more than he can prove.

2. *Is there any proof that Lane's method employed early can produce results as good as Langenbeck's employed later on?* *Cases* 15 (*Fig.* 118), 16, 17, and 18 are the only ones I have available. The oldest is not yet three years of age, and accurate results can hardly be expected. *Case* 15, an unusually bright child, has a short soft palate, and a definitely cleft-palate voice. The other three have good long and movable soft palates, but all are rather backward in learning to speak. *Case* 16 is perhaps a little deficient mentally—his older brother certainly is, but as far as I can make out from his rather limited vocabulary, I do not think that, judging by his speech, anyone would guess that his palate had ever been cleft. *Case* 17 is very shy. He is only two and three-quarter years old.

No tendency towards escape of air from the nose can be made out when the palate is raised in articulation, and I do not consider that he has cleft-palate speech. *Case* 18 is in exactly the same condition. She is the last but one of a family of six girls; I believe that she is a congenital syphilitic. She was a "waster" for the first seven months of her life, and is still backward. Her baby sister, aged about 1½ years, is relatively more advanced mentally than she. No sign of cleft-palate speech can be detected. Perhaps in all three cases I may be biassed, but I have devoted an hour and a half to each child in the bosom of its family in the endeavour to discover any weak point in my assertions.

3. *Is there any evidence that Lane's operation can produce a sufficiently long and mobile soft palate to prevent the habit of faulty articulation?* In addition to the three cases quoted above, *Case* 23 (*Fig.* 120) may be added to the list, but the operation was too recently performed to be sure that shortening of the soft palate will not occur.

4. *Do these three cases with anatomically good palates speak normally?* I have answered this as far as is at present possible.

The conclusion of this particular enquiry is, that it seems probable that the cleft-palate voice can be prevented, and that therefore it is legitimate to perform Lane's operation in selected cases at an age at which damage to the gums will not be necessary, i.e., from about nine months onwards.

FINAL CONCLUSIONS AS TO THE BEST TIME FOR OPERATION, AND THE BEST METHOD OF PERFORMING IT.

I approach this part of my work with a good deal of diffidence. It is almost impossible after a training in one school of thought to be absolutely unbiassed in dealing with a much debated question. One unconsciously exaggerates the achievements of those of his way of thinking, and is inclined to minimize the weak points of an operation he is in the habit of performing. On the other hand, a relative ignorance of the other side of the question is apt to prevent due regard being paid to its claims. It behoves us, therefore, to put aside all personal predilections and decide solely on the evidence before us. It is perhaps a matter not so much of the possibilities of each operation in the very best hands, as of the results we have a right to expect from the average surgeon who is in the habit of performing these manipulations. For this reason I have laid perhaps more stress than they deserve upon the results of my own performances. We have to consider the interests and the future of our patients rather than our own cherished beliefs, so that it is our duty to say, on the evidence, and apart from the possibilities of the future, what operation the surgeon should choose, and at what age he should perform it.

A. Minor Conclusions:—

1. It is desirable to close the cleft as soon as it can be done without preventing the production of a physiologically useful hard, and especially soft, palate.

2. It is desirable to close it even in cases where the patients have passed the most favourable age, as the speech is often much better than one has a right

to expect, and the use of an obturator is on the whole undesirable. Careful training in articulation is essential in every case.

3. As a rule, it is impossible to fashion a soft palate which is sufficiently long in a patient over twelve years of age. Better results can be obtained with a modern type of mechanical appliance.

4. Lane's operation cannot be dismissed as producing invariably, or even usually, a bad result.

5. Apart from its general employment, it is very useful in difficult cases, in wide clefts, and for the closure of holes left by any previous operation.

6. The whole cleft should be closed at the same time, whatever method be employed.

7. Careful measurements should be made before any operation is decided on.

8. By the restricted use of Lane's method in wide clefts, an efficient soft palate cannot as a rule be produced before the sixth month; in narrow and incomplete clefts, this is often possible earlier, but closure is not always advisable.

9. By Langenbeck's method with wide and complete clefts, an adequate soft palate cannot be relied on before the third year; with narrow and incomplete clefts, apart from the use of long lateral incisions (which are inadmissible at this age), we cannot generally expect an efficient soft palate before eighteen months.

B. Major Conclusions:—

10. The patient being about three years old, all the mechanical and nutritional factors being favourable, the evidence points strongly to the employment of a *median* rather than a flap operation.

11. If the case is below that age, and a complete cleft is present, the lip should be closed as soon as the infant is fit; no operation should be done on the palate until the alveolar margins of the cleft are nearly or completely in contact.

12. Before the age of three years, in cases where Langenbeck's operation cannot be performed without prejudice to the subsequent speech, there is a little evidence that a good result, both anatomically and functionally, can be obtained by the discreet and restricted use of Lane's methods. But, *unless the surgeon feels confident that he is able to produce this good result, he should wait until the conditions have become favourable for performing Langenbeck's operation.*

COMPLETE LIST OF CASES REFERRED TO.

Case	Age	Deformity	Operation	Comments
1. Wm. J.	3½ m'ths	Bipartite palate	Lane's	Failed. Lost sight of
2. Geo. Y.	6 weeks	,, ,,	Lane's (2 or 3)	Hard palate closed
3. John D.	2 years	,, ,,	Lane's (several)	Soft palate closed
4. Cyril M.	4 m'ths	,, ,,	Lane's	Complete closure; died of tubercle 6 months later
5. Maud H.	6 weeks	,, ,,	,,	Complete closure; died of gastritis 1 month later
6. Mary A.	6 ,,	Incomplete harelip	Owen's	No cleft palate
7. Harold S.	16 years	Cleft of soft and ⅔ hard palate	Restricted Lane's	Complete closure
8. Nettie F.	29 ,,	Bipartite palate spontaneous closure alveolus	,, ,,	,, ,,
9. Herbert H.	12 ,,	Soft and ⅔ hard palate	,, ,,	,, ,,
10. John H.	23 ,,	One inch of soft palate cleft	None	No deformity of speech
11. Winnie H.	4 m'ths	Soft and ⅔ hard palate	Lane's (twice)	Incomplete closure of soft palate
12. Mary C.	6 weeks	Incomplete harelip	Closure	No cleft palate
13. Edith Cr.	2½ years	Bifid uvula	Median	Operation by another surgeon; completely successful, but speech bad
14. Harold B.	6 ,,	Soft and ⅔ hard palate	Restricted Lane's	Complete closure
15. Agnes H.	9 m'ths	Bipartite, almost tripartite	Lane's	,, ,,
16. Craven G.	10 ,,	Soft and ½ inch of hard palate	Lane's No raw surface	,, ,,
17. Chas. L.	7 ,,	Bipartite palate	Lane's	,, ,,
18. Marion O.	7 ,,	Wide cleft of soft and ½ hard palate	,,	,, ,,
19. Muriel N.	14 ,,	Soft and ⅓ hard palate	Lane's (twice)	Soft palate incompletely closed
20. Mary H.	6 weeks	Bipartite palate	Lane's (several)	Complete closure
21. Maggie M.	? 20 years	Complete harelip	In childhood	No cleft palate
22. Alice G.	3 m'ths	Bipartite palate	Lip closed	Spontaneous closure of alveolus followed, palate not yet touched
23. Lawrence W.	7 weeks	,, ,,	Lip closed, palate at 4 months	Spontaneons closure of alveolus, after harelip operation. Complete closure of palate
24. Frank N.	9 m'ths	,, ,,	Lip closed	Spontaneous closure of alveolus followed, palate untouched
25. Leslie C.	6 days	Tripartite palate	Wedge removed from septum, Lip closed in two stages	No operation yet on palate
26. Catherine L.	8 m'ths	Bipartite palate	Closure of lip	No operation yet on palate
27. Ida B.	6 ,,	,, ,,	None	Died of pneumonia 2 months after discharge

COMPLETE LIST OF CASES—*continued.*

Case	Age	Deformity	Operation	Comments
28. John C. R.	2 m'ths	Almost bipartite	Double incomplete harelip closed	Died of pneumonia 6 months after discharge
29. David A. T.	4 days	Tripartite palate	Wedge removed from septum, lip closed in two stages	No operation yet on palate
30. Sydney H.	3 years	Bipartite palate, spontaneous closure of alveolus	Langenbeck	Complete closure
31. Elsie W.	4 ,,	Soft and $\frac{1}{4}$ inch hard palate	Langenbeck	,, ,,
32. Martha P.	12 ,,	Soft and $\frac{2}{3}$ hard palate	Restricted Lane's	Complete closure, unsuccessfull operation in infancy
33. Harry P.	16 ,,	Soft and $\frac{1}{4}$ hard palate	Artificial palate	Some improvement in speech
34. Frank A.	7 ,,	Bipartite palate, spontaneous closure of alveolus	Restricted Lane's	Complete closure
35. Margaret Law	12 ,,	Soft and $\frac{1}{2}$ hard palate	Restricted Lane's	Wide anterior end ; hole left closed at second operation
36. Olive S.	$3\frac{1}{2}$ m'ths	Tripartite palate	Author's on septum, harelip closed in two stages	Palate untouched
37. Tom B.	6 ,,	Soft palate cleft	Langenbeck (twice)	Complete closure
38. Anna B.	7 days	Complete premaxillo-maxillary cleft	Lip closed in two stages	Palate untouched, almost in contact
39. Edith M. M.	3 m'ths	Soft palate	Lane's	Incomplete closure at first attempt, now completely closed
40. Harold D.	9 years	Diphtheretic ulceration of soft palate	None	Diphtheria bacilli still present
41. Lily P.	4 ,,	Central perforation of soft palate and bifid uvula	Median (i) Flap (ii)	First operation enlarged opening, second operation closed hole
42. Fred'k. M.	$6\frac{1}{2}$,,	Soft and $\frac{2}{3}$ hard palate	Restricted Lane's	Complete failure ; very wide cleft, not seen since
43. Gladys B.	$11\frac{1}{2}$,,	Soft palate. Hard palate closed	None	Previous partial success as far as hard palate is concerned
44. Stanley R.	3 m'ths	Bipartite palate	Harelip closed	Palate untouched
45. John S.	32 years	Traumatic naso-labial fissure, necrosis of premaxilla	Plastic	Complete closure
46. Lily G.	37 ,,	Acquired central cleft of hard palate	Lane's	,, ,,
47. Mary W.	20 ,,	Soft and $\frac{1}{3}$ hard, wide cleft	Restricted Lane's	Died 20 minutes after end of operation (asphyxia)
48. Linda R.	7 m'ths	$\frac{2}{3}$ inch of hard palate	None yet	Soft palate closed at another hospital
49.	3 years	Soft palate cleft	Lane's	No raw surface left

RESULTS OF CLEFT PALATE OPERATIONS IN INFANTS.—COMPLETE CLEFTS.

No.	Case	Age	Operation	Result			
				Teeth	Hard Palate	Soft Palate	Speech, Etc.
I	2. Geo. F.	6 weeks	Lane's Hard palate alone operated on	Both sides uncovered. Now most of temp. teeth shed	Complete closure	Not closed. Later operation failed	Not good
II	5. Maud H.	6 ,,	Lane's Whole palate closed	Both sides uncovered	Complete closure	Complete closure	Died 1 month after operation
III	20. Mary H.	6 ,,	Lane's (several)	One side uncovered	Closed completely	Closed completely	Still too young for accurate judgment. Scarring likely to be prejudical
IV	1. Wm. J.	3½ months	Lane's Hard palate only	Both sides uncovered	Failure	—	Not seen since
V	4. Cyril M.	4 ,,	Lane's Whole palate closed	One side uncovered	Complete closure	Complete closure	Died of tubercle 6 months after operation
VI	17. Chas. L.	7 ,,	Lane's Whole palate closed	One side uncovered Teeth not damaged	Complete closure	Complete closure. mobile, not short	Speaks well for age
VII	15. Agnes H.	9 ,,	Lane's	One side uncovered Teeth not damaged	Complete closure Slightly scarring	Complete closure, mobile, short	Speaks badly
VIII	23. Lawrence W.	14 ,,	Lane's	Neither side uncovered	Complete closure	Complete closure, mobile, not short	Too recent to judge and not yet old enough

RESULTS OF CLEFT PALATE OPERATIONS IN INFANTS.—INCOMPLETE CLEFTS.

No.	Case	Age	Operation	Result			
				Teeth	Hard Palate	Soft Palate	Speech, Etc.
IX	39. Edith M.	3 months	Lane's Soft palate only	Not interfered with	Not cleft	Incomplete closure at 1st operation, complete closure 2nd	Too recent and too young
X	11. Winnie H.	4 ,,	Lane's	One side uncovered, no ill effects	Complete closure	Incomplete closure, further operation not allowed	Cleft palate speech
XI	18. Marion O.	7 ,,	Lane's	Some of back teeth on one side uncovered, all teeth bad	Complete closure, no obvious scarring	Complete closure, mobile, not short	Speaks well for age
XII	37. Tom B.	7 ,,	Langenbeck's	Not interfered with	Not cleft	Complete closure	Too young and too recent
XIII	16. Craven G.	10 ,,	Lane's No raw surface left	Not interfered with	Complete closure	Complete closure, mobile, not short	Speaks well for age
XIV	19. Muriel N.	14 ,,	Lane's	Not interfered with	Complete closure	Incomplete closure, further operation refused	Fair

RESULTS OF CLEFT PALATE OPERATIONS IN CHILDREN.

No.	Case	Age	Operation	Result			
				Teeth	Hard Palate	Soft Palate	Speech, Etc.
XV	3. John D.	2 years	Lane's, after failure of Langenbeck	Not interfered with	Not closed	Complete closure, thin palate	Not good
XVI	30. Sidney H.	3 ,,	Langenbeck	——	Complete closure	Very small hole	Too recent
XVII	49. M.	3 ,,	Lane's, no raw surface left	Not interfered with	Not cleft	Complete closure	Too recent
XVIII	31. Elsie W.	4 ,,	Langenbeck	——	Complete closure	Complete closure	Recent
XIX	41. Lily P.	4 ,,	Lane's, after failure of Langenbeck	Not interfered with	Not cleft	Complete closure of central cleft of soft palate and bifid uvula	Recent, improved
XX	14. Harold B.	6 ,,	Lane's	Not interfered with	Complete closure, slight scarring	Complete closure, mobile, rather short	Fair but not good
XXI	42. Fredk. M.	6½ ,,	Lane's	One molar exposed	Complete failure No further operation yet		
XXII	34. Frank A.	8 ,,	Lane's	Not interfered with	Complete closure	Complete closure, rather tight, mobile, a little short	Some improvement

RESULTS OF CLEFT PALATE OPERATIONS IN OLDER CHILDREN AND ADULTS.

No.	Case	Age	Type of Cleft	Operation	Result		
					Hard Palate	Soft Palate	Speech, Etc.
XXIII	9. Herbert H.	12 years	Soft and ⅔ hard palate	Lane's	Complete closure, slight scarring	Complete closure, mobile, rather short	Good
XXIV	32. Martha P.	12 ,,	Soft and ⅔ hard palate	,,	Complete closure, some scarring previously	Complete closure, mobile, short	Improved, fair; unsuccessful operation in infancy
XXV	35. Margaret L.	14 ,,	Soft and ½ hard palate	,,	Complete closure, some scarring	Complete closure, mobile short	Improved, fair
XXVI	7. Harold S.	16 ,,	Soft and ⅔ hard palate	,,	Complete closure. scarred	Complete closure, one side only, mobile, short	Bad speech, some improvement
XXVII	47. Mary W.	20 ,,	Soft and ⅓ hard palate	,,	Complete closure, with fair soft palate at end of operation		Died twenty minutes after operation (asphyxia)
XXVIII	8. Nettie F.	29 ,,	Soft and ⅔ hard palate	,,	Complete closure, some scarring	Complete closure, fair mobility, short	Not much improvement
XXIX	45. John S,	32 ,,	Loss of pre-maxillary segment by injury and necrosis	Plastic	Complete closure	Not affected	Not affected
XXX	46. F.	37 ,,	Acquired central cleft of hard palate	Lane's	,, ,,	Not affected	Restored to normal

REFERENCES.

[1] BERRY AND LEGG, Harelip and Cleft Palate. 1912.
[2] J. ERNEST FRAZER, *Journal of Anatomy and Physiology*, 1912, July, 416.
[3] J. ERNEST FRAZER, *Ibid.*, 1911, July, 347.
[4] PROFESSOR A. KEITH, Congenital Malformations of the Palate, Face and Neck. *Brit. Med. Jour.*, 1909, ii, 310.
[5] DR. GUSTAV HAUG (quoted by KEITH). See reference (4).
[6] BERRY, *Loc. cit.*, Appendix II.
[7] BERRY AND LEGG, *Loc. cit.*, Appendix III.
[8] JOHAN ULRICH, Copenhagen. Cleft Palate, *Lancet*, 1911, i.
[9] BERRY, *Loc. cit.*, 58 and 59.
[10] WILLIAM ROSE, Harelip and Cleft Palate. 1891, 8.
[11] KEITH, *Loc. cit.*, 313.
[12] KEITH, *Loc. cit.*, 313.
[13] BERRY, *Loc. cit.*, 13.
[14] BERRY, *Loc. cit.*, 12.
[15] KEITH, *Loc. cit.*, 313.
[16] ROSE, *Loc. cit.*, 13.
[17] BERRY, *Loc. cit.*, 52 and 53.
[18] KEITH, *Loc. cit.*, 311.
[19] BERRY, *Loc. cit.*, 75.
[20] BERRY, B. M. A., Birmingham Meeting, July, 1911.
[21] HALLIBURTON, Handbook of Physiology. 1896, xxx, 325 etc.
[22] BERRY, *Loc. cit.*, iv, 86 et seq.
[23] SPITZY, GRATZ, PFAUNDLER AND SCHLOSSMANN, Diseases of Children, vol. v, English translation, 32.
[24] LANE, Cleft Palate and Harelip. 2nd ed., 1908.
[25] BERRY, *Loc. cit.*, 94.
[26] R. W. MURRAY, *Lancet*, 1911, i, 1453.
[27] BINNIE, Manual of Operative Surgery. 1912.
[28] BERRY, *Loc. cit.*, 265 et seq.
[29] SINCLAIR KIRK, A Note on Cleft Palate Operations, *Brit. Med. Jour.*, 1910, ii.
[30] EDMUND OWEN, Keen's Surgery, vol. iii, Article, Cleft Palate.
[31] WALSHAM AND SPENCER, Surgery, its Theory and Practice. 1906.
[32] EDMUND OWEN, Cleft Palate and Harelip. Medical Monograph Series, 1904
[33] L. E. BARRINGTON-WARD, Proceedings of the Royal Society of Medicine, Surgical Section, June, 1911, 191 and 193.
[34] G. E. WAUGH, *Ibid.*, 186.
[35] W. G. SPENCER, *Ibid.*, 197.
[36] T. H. KELLOCK, *Ibid.*, 190.
[37] J. BERRY, *Ibid.*, p. 184.

VISITS TO SURGICAL CLINICS AT HOME AND ABROAD.

SIR ARBUTHNOT LANE'S OPERATIVE TREATMENT OF FRACTURES AT GUY'S HOSPITAL.

ONE of the most attractive surgical clinics in London is that of Sir Arbuthnot Lane at Guy's Hospital. Pioneer work is always interesting, and the large amount of new work which has originated in this clinic is well known. Sir Berkeley Moynihan aptly said at the recent meeting of the British Medical Association: "Arbuthnot Lane is a man whose mind easily moves along new paths," and perhaps the most famous of these new paths is that which led him to operate for simple fractures as a matter of routine.

Sir Arbuthnot Lane has charge of some fifty beds at Guy's Hospital, and ordinarily operates on Mondays, Tuesdays, Thursdays, and Fridays at 2 p.m. Operations are attended by numerous visitors, many of whom come from America, where Lane's work has aroused widespread interest. Visitors are sure of a warm welcome and of seeing instructive cases.

The visit here described was paid on July 15, Sir Arbuthnot having promised to perform operations on fractured bones on that day. Most of his work at the present time is concerned with operations for intestinal stasis, and it is hoped that this subject will be dealt with in this JOURNAL at some future date.

Interesting cases of colectomy and ileosigmoidostomy were shown in the wards before operation: the patients themselves described the good results of operation, one woman who had suffered from rheumatoid arthritis being particularly enthusiastic.

The general principles of this surgeon's operative treatment of fractures are well known; but reference may be made to some of the details of technique, for it is clear to onlookers that the success of these operations depends entirely on untiring attention to details. The methods employed appear easy, effective, and uncomplicated; they have two main objects—perfect asepsis, and perfect approximation of the fragments.

The supreme importance of asepsis is made obvious throughout the operation. Every possible precaution is taken to prevent the introduction into the wound of anything which may conceivably have become soiled. Although rubber gloves are worn, fingers are never put into the wound; in fact, they are scarcely ever near it, for all the instruments used are of great length: the bone-holding forceps, for instance, range up to 17 inches, and the screwdriver and the periosteum elevators are 12 inches long. A large number of gauze swabs are used; these are held and applied with long forceps, being thrown away as soon as they become soiled. The holes for the screws are drilled by simple hand awls.

The preparation of the skin is carried out by the iodine method, a 3 per cent solution of iodine in spirit being used. A wide area is prepared, and the iodine is applied freely for the last time just before the operation is commenced. An incision of ample length is made over the site of the fracture, and several folds of gauze are at once clamped along the skin edges, so that none of the skin is exposed during the rest of the operation. Lane's light tissue forceps are used for this purpose, and in an ordinary case eight to twelve pairs are applied.

The management of hæmorrhage in these large wounds is interesting. A tourniquet is never used: smaller vessels are ignored, larger ones are seized with pressure forceps, which are released at the end of the operation; no ligatures are applied. The forceps are made especially strong in order to exert sufficient pressure to obliterate permanently the lumen of the vessels; in this way the necessity for introducing the gloved hand into the wound for the purpose of tying a ligature is avoided. The closure of the wound is effected by suture of the skin edges with Michel's metal clips. Sir Arbuthnot holds the skin edges accurately in apposition with two pairs of dissecting forceps, whilst the house surgeon attaches the clips. A large dressing is then applied, and firmly bandaged over the wound. It is noticeable that no attempt is made to suture the wound in the deep fascia, and that the wounds are never drained. The limb is kept in splints for four weeks after the operation, or even longer in some cases.

Operations were commenced at 2.20 p.m., and the four cases, all of which were fractures of the upper extremity, were completed shortly before five o'clock. Some thirty visitors were present. In accordance with the routine practice, they divested themselves of their coats in a dressing-room near the theatre, and were there provided with sterilized overalls, caps, and mouth covers, before entering.

The operating theatre is small and old-fashioned, and one was struck by the fact that such up-to-date and delicate work could be so well carried out amid such simple surroundings.

The cases are not usually seen by the operator before the operation. The diagnosis is entirely a matter of skiagraphy. The *x*-ray negatives of the case are placed on a shelf against the window, and this seems to be the only knowledge which the operator desires of the problem which lies before him. It is, perhaps, scarcely necessary to add, that no other treatment is resorted to before the operation is undertaken. The latter is regarded as the best treatment, and the sooner it is carried out the better for the patient.

The first case was that of a man aged 42, who, fourteen days previously, had sustained a comminuted fracture of the lower end of the radius. The skiagram showed outward displacement of the lower fragment, which carried the hand with it. It was clear that treatment by non-operative means would result in decided deformity, and almost certainly in some impairment of function. A 4-inch incision was made over the outer aspect of the fracture, which was then freely exposed. A small detached fragment of bone was lifted out and laid on a sterile towel; the two main fragments were then levered accurately into position with long forceps, an assistant making strong traction on the hand. A 2-inch plate was put into position and fixed with four screws. The detached fragment was

then bathed in warm saline solution and replaced, after which it was obvious to onlookers that the restoration of the alignment of the bone was perfect.

The second case was one of a transverse fracture of the radius and ulna in a boy aged 9; the radial fracture was comminuted. Both bones were exposed and plated; the plates used carrying four screws, and being about 1½ inches long. There was a little difficulty in getting the screws to hold in the radius, and two of them were removed and replaced by larger ones.

The third case was that of an unreduced fracture dislocation of the head of the humerus in a stout man aged 47. An incision, 5½ inches long, was made over the outer aspect of the shoulder-joint. The deltoid muscle was then split, and the damaged bone carefully exposed. There was some difficulty in reduction; but this was eventually effected by splitting the tuberosities, after which the fragments were easily levered into position; no plates were inserted.

The last case was a boy aged 10, with a comminuted fracture just outside the centre of the left clavicle: a skiagram showed considerable separation between the two main fragments. An incision 3 inches in length was made along the clavicle, and the site of fracture was carefully and cleanly exposed: a loose triangular piece of bone was temporarily removed. The two main fragments were seized with forceps and held firmly in position; a 2-inch plate was then fixed with four screws, after which the loose piece was replaced.

The impressions made by the afternoon's work were many. The chief perhaps was that of the keen enthusiasm of the operator, an enthusiasm which was shared by all who worked with him. Sir Arbuthnot evidently had the advantage of being helped by a very efficient and reliable house-surgeon—the organisation appeared to be perfect; for all concerned with the operations seemed to know their parts exactly.

The next impression was that of confident asepsis, which guaranteed the safety of the patient. One knows that the disasters and failures in these cases have been due mostly to septic infection, and a visit to this clinic makes one feel more strongly than ever that a surgeon should not undertake an operation for a simple fracture unless he is certain of asepsis. Sir Arbuthnot Lane personally superintends every detail connected with the operation, and one feels that the possibilities of sepsis are eliminated as far as is humanly possible.

Lastly, one was struck by the perfect restoration of the damaged bones. The cases dealt with on this afternoon were such as most surgeons would treat without operation, cases for which some would say that operation was unnecessary. In this clinic all simple fractures are operated upon as a matter of routine, on the grounds that by this means the best possible results are obtained: and there can be no doubt that Sir Arbuthnot will get results in those four cases which, as regards anatomical and functional restoration, will be difficult to beat or even equal by any form of non-operative treatment. Those who are not convinced about this matter should go and see.

THE CLINIC OF DR. LAMBOTTE, ANTWERP.

THE operative treatment of fractures is making such rapid progress in these islands, that a short account of the remarkably successful work of a distinguished Continental colleague who has made this subject a special study may assist in clearing away a residuum of prejudice which perhaps still exists against operation.

Dr. Lambotte's interest in the operative treatment of fractures dates back as far as 1888, a time when he was intern to his brother, Elie Lambotte, at the Lazarette of Schaerbeek. After an internat in the hospitals of Antwerp, he became chief of service at the Stuivenberg Hospital, an institution which serves a large port and where he has obtained a ripe experience.

FIG. 190.—THE INSTITUT ST. CAMILLE.

A short while ago he resigned his appointment at the Stuivenberg, though still a young and energetic man, and now devotes himself to work at the Institut St. Camille ; he remains, however, consulting surgeon to his former hospital.

The Institut St. Camille (*Fig.* 190) is a hospital of 160 beds administered by a religious sisterhood. It is well equipped with all apparatus and appliances, *x*-rays, etc., to meet modern requirements. The wards are adapted to suit the financial resources of the patients, who all pay some contribution. Those who are unable to pay the regular charges are collected into large wards, while those who wish a room to themselves can have it by paying higher fees.

The operating theatre is high and roomy, being lighted by five large windows which come to within a few feet of the floor ; the lower half of the windows are of ground glass. The only furnishings are the pedestal operating table, pedal

wash-hand basins, and instrument- and dressing-tables. An anæsthetic room adjoins, containing a cupboard for surgeons' clothes. The patient, when admitted

FIG. 191.—Dr. Lambotte in his theatre.

to hospital, is carefully examined; the injured parts are radiographed and cleaned with soap and water, shaved, wrapped in compresses saturated in camphorated alcohol, and covered with a thick aseptic dressing.

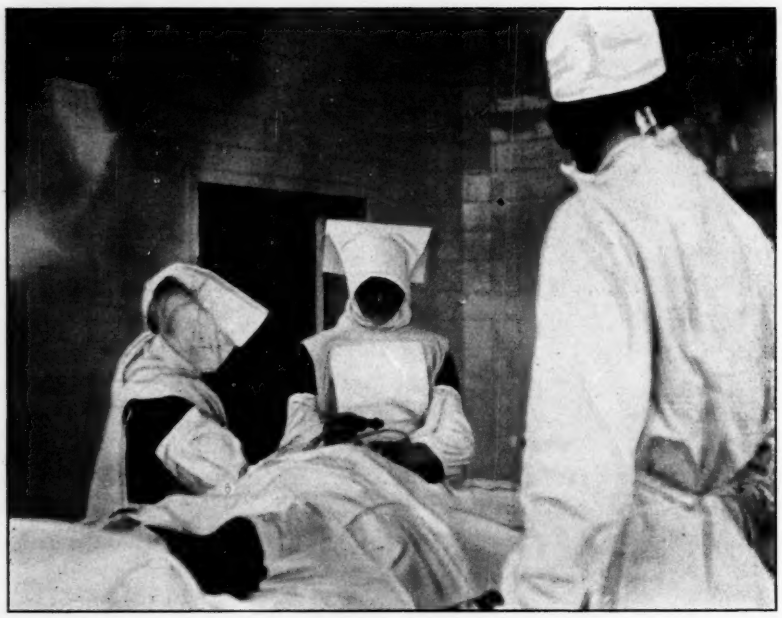


FIG. 192.—A sister inducing anæsthesia.

This preparation is repeated every two days up to the moment of intervention. The period of preparation lasts from ten to fifteen days on an average, the

shorter period for the upper limbs, the longer for the lower; bullæ or erosions are dealt with by the application of iodine during this time of waiting. It is customary to inject the patient with a dose of 10 centigrams of nucleinic acid on the eve of the operation, and two or three injections are made on the days following operation.

FIG. 193.—The foot-piece of the traction lever bandaged to the foot.

Anæsthesia is usually by chloroform, and is frequently induced and maintained by a sister who is quite familiar with the art (*Fig.* 192) and can skilfully continue an even, steady sleep.

When the lower limb, especially the femur, is to be operated on, the foot-piece of the traction lever is bandaged to the foot, the ring projecting for attachment to the traction arm (*Fig.* 193). Just before the operation, the limb is painted with tincture of iodine.

Sterile wraps cover the patient and the table, leaving the field bare. Dr. Thoumsin is ordinarily the assistant, and knows the technique of his chief to the minutest detail; he does the right thing at the right time, and does not get in the way. The hands of the surgeons are thoroughly cleansed, rinsed in alcohol, and sterilized cotton gloves are put on; these are frequently changed during the procedure and whenever there is any trace of blood on them. Lambotte prefers these gloves to rubber, on account of the danger consequent on tearing the latter while handling heavy tools. Sterilized overalls are worn, and the arms are covered down to the wrists; caps and the spectacle form of mask are put on; visitors must wear overalls.

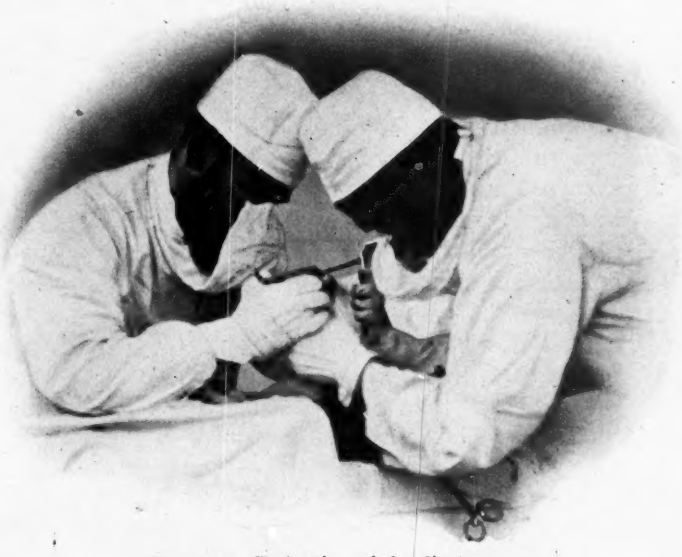


FIG. 194.—Reduction of the displacement.

The instruments, which are boiled for half an hour, are taken up only by the surgeon; fingers never enter the wound; swabs are held on forceps. The large skin wound is retracted with a heavy tenaculum type of forceps; the muscles and torn periosteum are separated with an elevator, the fragments clearly demonstrated, and the ends bared; spouting vessels are secured with forceps. Rarely is a ligature used. One large straight forceps with a ratchet is now applied firmly to each fragment well away from the freshened ends, and traction is made by surgeon and assistant. When accurate apposition is achieved, the large holding forceps is applied to the seat of fracture and, with the ratchet in action, the reduced displacement is soundly and strongly held; the traction forceps are now taken off, and a plate or the fixateur placed with the greatest ease (*Fig.* 194).

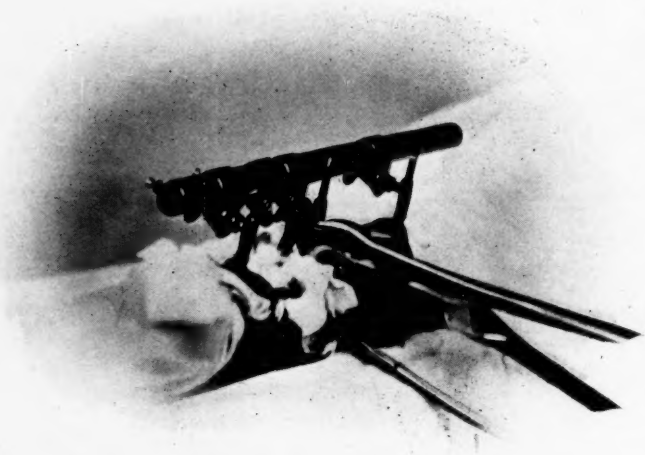


FIG. 195.—The fixateur in position, ready for removal of the holding forceps.

Fig. 195 shows a fixateur in position just before the final removal of the holding forceps.

The fixateur is an instrument after the pattern of the well-known Parkhill clamp, but it is much more easily applied. The horizontal bar holds the rods, which are driven in at right angles to the bone with a hand-drill; the drill is then uncoupled, and the rods are fixed by the bar in a strong grasp, maintaining the apposition without the faintest movement; four or five or more rods may be necessary, according to the length of the bone.

FIG. 196.—A plate being secured by a screwdriver.

If it is desired to use a plate, Lambotte uses hardened aluminium hollowed

to fit the contour of the bone ; the jaws of the holding forceps are wide enough to permit the passage of a plate held in a forceps between them on the bone ; the screws, being cutting screws, can be attached to the drill and rapidly turned home, the final turns being made with a hand screwdriver (*Fig.* 196).

Fig. 197 shows a fixateur in position in the thigh at the end of three weeks ; the wound is healed and the sutures are removed ; it remains in for another week.

Dr. Lambotte now uses the fixateur for the femur but rarely, as he prefers a plate ; but he employs it most frequently for the tibia, for in this superficial situation he thinks the plate is not quite so good, as it sometimes requires removal later. If traction by the forceps is not sufficient in lower-limb cases to draw the fragments into good alignment and apposition, a special tractor is brought into action. This instrument consists of a crutch which fits into the perineum, passing down inside the leg as far as the foot ; it can be lengthened or

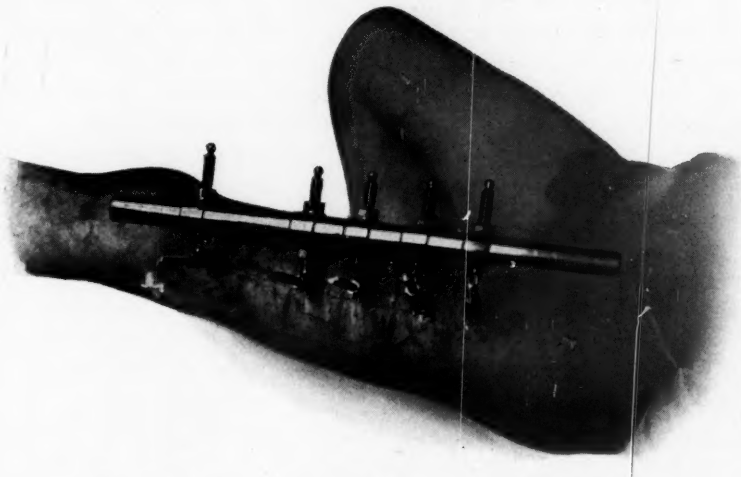


FIG. 197.—Fixateur in position three weeks after operation.

shortened according to requirements. The traction arm passes across the sole outwards at right angles to the crutch portion, and is connected to the ring of the foot-piece already bandaged to the foot ; a removable hand-piece slips on to the foot-piece at the toes, and is used for the purpose of rotating the limb in any desired direction (*see Fig.* 193). Extension to the amount of 500 lb. can easily be applied.

In some cases the fragments are secured by the method of cerclage, that is, three or four strong wires hooped round the bone : these wires are placed by means of an instrument somewhat like a long, well-curved aneurysm needle ; the eye of the instrument is made to project over the bone, and the wire end, acutely bent, is inserted into the eye and drawn round, twisted carefully perpendicularly to the circle, and cut off somewhat long, lest there be a tendency to unwind.

There are other methods in use, and these are fully described in the published works (" L'Intervention Operatoire dans les Fractures," Lambertin, Bruxelles, 1907 ; and " Chirurgie Operatoire des Fractures," Masson & Cie., Paris, 1913, 30 frs.).

The wound is sewn up, without drainage save in infected cases, with interrupted sutures of fine twine (common green and white twisted cord) sterilized in an autoclave. The wound is wiped with alcohol, and a copious dressing of sterile gauze, enveloped in a sterile towel, is fixed by a sterile bandage, and the technique is complete. No splints are used, and the limb is allowed to rest in the most comfortable position. The day after the operation the first dressing is removed and a fresh one applied with full aseptic care ; this remains until from the tenth to the fifteenth day, when the stitches are removed.

Dr. Lambotte holds strongly that to ensure a satisfactory functional result it is necessary to obtain a good anatomical reconstitution. This view is in full accord with the findings of the Fractures Committee of the British Medical Association.

While watching this surgeon at work, the visitor is likely to forget that the operative treatment of fractures is one of the most difficult and trying procedures in surgery. The remarkable ease, dexterity, and mastery of elegant carpentry which is displayed is fascinating, while the absolute care for detail and forethought call forth the greatest admiration.

During several visits to the clinic, opportunities were given of seeing the patients days, weeks, and years after operation, and it is gratifying to be able to testify that the results are good, and the convalescence is rapid and uneventful.

The end results of some 60 cases which were examined are thoroughly satisfactory ; dock workers, labourers, and others, were quite ready to demonstrate the full use they had of their limbs, and to express themselves able to work as well as ever. Many of them had the plate and screws quietly in position, and in the cerclage cases, the ends of the wires could be frequently felt ; yet the patients stated that no inconvenience was caused.

It seems to the writer that the moving sentiment of this clinic is the aphorism of Huxley, " Accuracy is the foundation of everything else."

INSTRUCTIVE MISTAKES.

CASE 5.

FATAL RUPTURE OF EMPYEMA INTO BRONCHUS DURING ANÆSTHESIA.

A man of 56, a heavy drinker, contracted pleurisy of the right side. A copious empyema developed, and had lasted a considerable time before an exploratory puncture revealed its purulent nature. There was no coughing, and the respiratory distress was not excessive. A surgeon was invited the following morning to open and drain the pleura freely. There was no trained nurse in attendance, and the fact that a couple of hours before the projected operation the patient had coughed up half a drachm of pus was not reported to the medical attendants. The patient was nervous, and insisted upon a general anæsthetic. Chloroform was given, but violent struggling ensued after a few inhalations. Suddenly, the pharynx and mouth filled up with pus, and in a few seconds a pint or more flowed from the mouth and nose. The pus overflowing into both bronchi promptly drowned the patient in his own pus. Attempts at artificial respiration only aggravated the condition by pumping up more pus, while respiratory and cardiac stimulants were useless.

Obviously, the purulent expectoration denoted the beginning of a broncho-pleural fistula, which the struggling under the chloroform rapidly developed. It was unfortunate that the sample expectoration was not shown or mentioned to the surgeon, as the catastrophe might have been averted either by employing local anæsthesia merely, or by the preliminary emptying of the pleura of the bulk of its fluid by the use of the aspirator.

CASE 6.

DISTENDED SACCULE OF THE BLADDER, DIAGNOSED AS A CÆCAL VOLVULUS.

A man of 79, in fair general health, but a member of a gouty family, who had not suffered from any urinary discomfort, noticeable impediment, or frequency in urination, was suddenly seized with abdominal pains and urgent vomiting, which was copious and projectile. The pains were paroxysmal and referred to the lower abdomen, and especially to the right iliac fossa, where a firm elastic swelling could be seen and felt, and which hardened palpably during the pains. This was the only form of visible peristalsis observed. The swelling was only relatively dull on percussion, and there was no obvious hypogastric fullness. No urinary or rectal tenesmus was complained of. The bowels had been regular in action, and, after enemata, fæces and flatus ceased to be expelled. Purgatives could not be retained upon the stomach. and therefore failed to act.

The prostate was much enlarged, but there was no cystitis, and no catheter was passed, as the patient passed water occasionally, and apparently did not require instrumental aid. The pulse and temperature remained normal, and there was no general abdominal distention or tenderness. The case was deemed one of primary surgical urgency; the diagnosis of volvulus in the cæcal region was made, and an immediate cœliotomy carried out. As in a private house no means were available for testing urine, no examination was made. Ether was well borne and rapidly recovered from, and apparently without aggravation of the condition. The iliac swelling was found to be a large distended saccule of a deformed bladder; no actual intestinal obstruction was discovered, although the entire length of the large and small intestines was methodically examined. An elbowed catheter when passed caused the disappearance of the swelling, and this instrument was used daily in the subsequent treatment. The wound healed by first intention. The vomiting continued after operation, with occasional hiccough, but not so urgently as before, when the bladder was distended. Purgatives acted at intervals satisfactorily, and the bladder was washed out each day. The general condition did not materially improve, and the patient died six weeks after the operation from uræmic coma.

Had a catheter been used before the operation, the mistaking of a distended and deformed bladder for a volvulus would not have been made; and an examination of the urine for low specific gravity, and greatly diminished urea output, would have led to the estimate of the case being one of uræmic vomiting, doubtless produced by chronic retention of urine and atrophy of the kidney substance by backward pressure long maintained by the prostatic hypertrophy. The operation, happily recovered from, was therefore of no service. On the other hand, had prostatectomy been substituted for the intestinal project, probably a disastrous result would have followed, as the high degree of renal inadequacy which existed would have rendered any operation nugatory, even though based upon a correct view of the essential nature of the conditions.

CASE 7.

INFLAMMATORY APPENDIX TUMOUR REMOVED AS A MALIGNANT GROWTH.

Perhaps the most instructive of mistakes are those occurring in connection with common conditions. But the knowledge to be gained from uncommon cases may lead to the more frequent recognition of such varieties. Indeed, and especially in the lesser degrees, such pathological conditions may be found of sufficient frequency to form part of the knowledge necessary to the general practitioner. The patient in this case was a hale lady aged 72 years. Some time previously she had suffered from movable kidneys, the left being fixed by nephrorrhaphy. For about the last year she experienced many attacks of pain and discomfort in the right side, necessitating remaining in bed. The pain was not severe, so no doctor was consulted until a tumour was found by the patient herself in the right side of the abdomen. There was thus no knowledge whether these attacks were accompanied by pyrexia. Vomiting was absent, and the bowels were inactive during the attacks. On examination, a non-tender,

slightly movable mass (*Fig.* 198) was felt in the lower part of the right loin and the upper part of the right iliac fossa. It was dull on percussion, and extended to the back of the upper part of the iliac fossa but not into the loin. The urine revealed no abnormalities.

The tumour was regarded as probably a carcinoma of cæcum. As she was known to have had movable kidneys, alternative diagnoses were: prolapsed kidney partially fixed by inflammation, mesenteric glands, and tuberculous peritonitis. It was proposed to explore the abdomen.

The abdomen was opened through the right rectus. On opening the peritoneum the cæcum presented, and was found to be attached by the caput coli to the back of the upper part of the iliac fossa. After "packing off" the rest of the peritoneal cavity, this was detached, and a distended yellowish knob

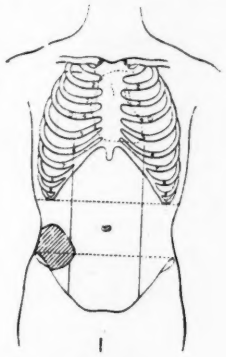


FIG. 198.

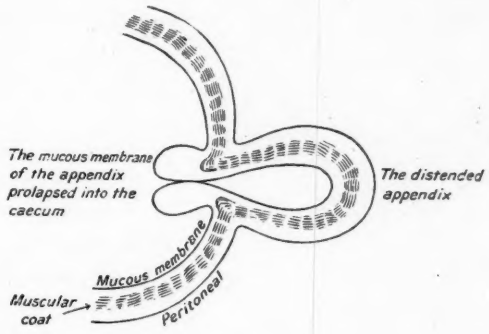


FIG. 199.

(the anæmic end of the appendix) was seen to be protruding from it. The intestine was clamped, the caput coli removed, and the bowel sutured. The remainder of the operation was done in the ordinary way.

An examination of the specimen removed showed:—

1. The prolapsed mucous membrane of the appendix protruding into the cæcum (*Fig.* 199).

2. Many adhesions from appendicitis consequent on the damming of its contents in the cæcum.

3. Partial "strangulation" of the appendix, shown by its anæmic condition.

4. The inflammatory nature of the tumour.

This case is instructive as showing the possibility of the condition of the patient being due to inflammatory conditions of the appendix even when the age has exceeded threescore and ten.

CASES 8, 9, 10.

WOUNDS OF THE HEPATIC AND COMMON DUCTS DURING THE OPERATION OF CHOLECYSTECTOMY.

The notes of these three operations are of interest, in that they show the danger of injury to important neighbouring structures when cholecystectomy has to be performed in cases where there is a broad sessile attachment of the

gall-bladder, formed either by a widely dilated and possibly adherent cystic duct, or by adhesions to the gall-bladder itself.

Case 8.—**WOUNDING OF THE RIGHT HEPATIC DUCT.**

Operation.—Kocher's incision. On opening the abdomen, the gall-bladder, which was small, was seen to have an hour-glass narrowing in its middle, there being one stone in the distal compartment and several smaller ones in the proximal. The fundus was somewhat inflamed, and had an adhesion fixing it to the omentum. After division and ligation of this adhesion and digital examination of the common duct, the cystic duct was defined, clamped, and divided, the stump being then cauterized and ligatured. In the subsequent dissection to isolate the cystic artery, a structure was exposed at the base of the gall-bladder which was thought to be a vein. This structure was clamped and divided. Whilst tying, the ligature broke and the clip had to be re-applied; the whole mass originally held in the clip was not picked up however. The cystic artery was then defined and ligatured. In stripping back the neck of the gall-bladder, the large right branch of the portal vein was exposed as it lay in the portal sulcus; it was somewhat distorted owing to an adhesion to the neck of the gall-bladder. After cholecystectomy was completed, a slight escape of bile was observed coming from the region of the cystic artery stump. This escape was not from the cystic stump, which was securely ligatured, but flowed from a duct which had been wounded obliquely near the cystic artery. Some time was spent in endeavouring to secure the opening, but the attempt was abandoned eventually as the amount of bile was inconsiderable, and the opening in the duct was slit-like. The duct wounded was the right hepatic, which had been distorted in a similar fashion to the right branch of the portal vein. This duct was probably partially included in the ligature which broke.

FIG. 200.
GALL-BLADDER WITH PIECE OF RIGHT HEPATIC DUCT ATTACHED

A split rubber drainage tube was stitched down to the stump of the cystic duct, and surrounding this a larger tube was passed so as to drain the right kidney pouch. The wound was then closed.

Case 9—**WOUNDING OF THE COMMON HEPATIC DUCT.**

Operation.—Mayo Robson's oblique incision. On opening the abdomen, the gall-bladder was found to contain many large stones. It was fixed by numerous adhesions to the duodenum and omentum. These adhesions were ligated and divided. Several large stones of a similar size to those felt in the gall-bladder were present in the common duct, and one was in the ampulla of Vater, which latter was displaced by digital manipulation up into the common duct. Cholecystectomy was now performed; the gall-bladder being first freed from the liver and stuffed downwards. The cystic artery was clamped, divided,

and ligated. In making the division of the cystic duct, a piece of the anterior wall of the common hepatic duct was taken away, it having been adherent to the posterior aspect of the cystic duct. Six large stones were removed from the common duct, and the wound in the hepatic duct was closed with some difficulty by interrupted catgut sutures. A drainage tube was passed into the common duct through the cystic duct stump and below the line of suture. A large split rubber drain was passed down to the kidney pouch, whilst a piece of rubber tissue was tucked round the two tubes so as to shut off the operation area as completely as possible.

FIG. 201.
GALL-BLADDER WITH PIECE OF COMMON HEPATIC DUCT ATTACHED.

Case 10.—**WOUNDING OF THE COMMON HEPATIC DUCT AND OF THE COMMON DUCT.**

Operation.—Mayo Robson's incision. On opening the abdomen, the gall-bladder was found to be buried beneath a mass of adhesions, which were separated with difficulty, many bleeding points having to be ligated. The gall-bladder was atrophic and contained many stones: a large stone lay in the cystic duct, which was markedly dilated. The junction of the cystic duct with the common hepatic duct was exposed, and the cystic duct clipped, cut across, and cauterized. The gall-bladder was then dissected upwards from the liver and removed.

FIG. 202.
GALL-BLADDER WITH PIECE OF COMMON HEPATIC DUCT AND COMMON DUCT ATTACHED.

On examining the region of the cystic duct, it was found that there were three openings—the true cystic stump, which was held in the clip; above this, the common hepatic duct was cut into near its termination; whilst below, the commencement of the common duct was wounded. Examination of the specimen showed a portion of the common duct and of the common hepatic duct adherent to the gall-bladder.

The common hepatic duct was sutured and a tube tied into the common duct below the line of suture. A drainage tube was placed down to the kidney pouch and the abdomen closed.

All three cases recovered

CASE 11.

GASTRO-COLIC FISTULA: IMMEDIATE RESECTION, AND DEATH.

The patient, a man aged 46, was admitted into hospital with fæcal vomiting. For some months previous he had been an inmate of one of the London hospitals, suffering from an acute illness of which vomiting (fæcal ?) was the chief symptom.

Subsequently, he had constant attacks of dyspepsia, and frequently vomited, especially after taking a full meal. His bowels became increasingly troublesome. There was no blood either in the vomit or the stools. He progressively lost weight. Three days prior to admission he had passed neither fæces nor wind per anum, in spite of purgatives and enemata, but had been vomiting stuff like a diarrhœal motion. He had taken only milk.

On admission his temperature was normal, the pulse 95, soft and ill-sustained, though of good volume. The patient was wasted, and the cheeks were rather sunken, with a malar flush. He looked pinched, but had not the anxious expression of acute abdominal conditions. His voice was good, the tongue raw and red, but moist. No vomiting for ten hours preceding admission.

The abdomen was flat, not tender, and moved freely on respiration. It was not rigid. Just above, and to the left of the umbilicus, there could be felt an irregular hard swelling descending with respiration. Its boundaries were ill-defined, but it was included within a circle of about three inches in diameter. There was slight deep tenderness over it, no cutaneous hyperalgesia. The rectum was empty. No visible coiling could be seen, but the empty cæcum was felt by the physician to be contracting, and a peristaltic hardening was detected just below the swelling. The stomach was not dilated.

Two hours after admission the patient brought up one and a half pints of distinctly fæcal grumous yellowish fluid.

It was agreed that an operation was urgent. The diagnosis was made of primary growth, either in the transverse colon or the stomach, and involving both these viscera. A fistulous communication between them was considered probable. The stomach having been washed out, an incision was made above the umbilicus just to the right of the middle line, and a mobile growth was delivered through it. It consisted of an annular growth of the transverse colon, adherent to the greater curvature of the stomach, and a mass of growth extended backwards and upwards from it into the transverse mesocolon, but not as far as the root of the mesocolon.

The stomach, being clamped round the seat of attachment to the growth, was resected on the colon side of the clamp, and the incision sewn up with two continuous sutures, one including all the coats, the other a peritoneal suture.

The colon was now clamped on either side of the growth, and cut through, about eight inches of it being removed. The proximal colon was enlarged and hypertrophical, and its diameter was about one and a half times that of the distal portion. The mesocolon was now tied in sections, and difficulty was experienced in getting behind the tongue of growth which ran back into it. The ends of the colon were now joined end to end by continuous peritoneal and through-and-through sutures, until only an opening sufficiently large to admit a Paul's tube was left in front. The Paul's tube was held in place by a purse-string suture round this opening. The packing was now removed, the peritoneum swabbed with weak perchloride, and the abdomen closed by through-and-through fishing-gut sutures. The Paul's tube protruding through the lower angle of the wound was kept in place by passing one end of the purse-string suture through the abdominal wall, and tying it to the other end.

The operation took one and a half hours. The patient appeared to stand it well, and the pulse, when he was taken back to bed, was under 100. He came

round and spoke. Four hours later, the pulse suddenly failed, and in spite of subcutaneous saline injections, bandaging of the limbs, and other measures, the patient died, apparently from shock. At the autopsy, the lines of suture were sound and watertight, and no growth was detected anywhere in the body. Owing to the objections of the friends, the thorax was not opened.

The transverse colon had, by the contraction of the growth, been pulled up towards the stomach in an acute bend. At this bend its lumen was not wider than the little finger. The distended proximal colon ran almost directly upwards and to the left into a fistulous channel, with thick sloughy walls, about ¾ in. in length, and just large enough to admit the little finger. This channel opened into the stomach about opposite the greater curvature. The walls of the stomach were not much thickened nor infiltrated, but the area of adhesion of the growth to the exterior of the stomach was as large as a five-shilling piece. The area of stomach-wall excised measured about 2½ by 2 in.

This case will illustrate the mistake so easily made in abdominal surgery, of attempting too much. It is of course well known that in acute obstruction in the large intestine, immediate resection is fatal. In the present case, the large intestine was not actually obstructed, since it could discharge its contents into the stomach. Death appears to have been due to shock, the result of too severe an operation. It would have been better to have been content with a cæcostomy, possibly combined with separation of the stomach from the colon by resection of an oval piece of the stomach-wall and suture of the stomach. The excised gastric mucosa would have been left on the surface of the abdominal wound. At a second operation the growth could have been excised, with circular union of the divided ends of the transverse colon.

CASE 12.

TUMOUR OF THE LEFT VAGUS REMOVED IN MISTAKE FOR A FIBROMA, WITH FATAL RESULT.

THE patient, a little girl aged five, was one of a healthy family of four children who, as well as her parents, were all alive and in good health.

Twelve months before she came under observation some "enlarged glands" were noted at the left angle of the mandible; these were treated by the application of hot fomentations, and are said to have temporarily improved.

During the last two months the swelling had been enlarging, the child was unwell, and it was noticed that when asleep, respiration was difficult.

On admission to the hospital it was noted that the child looked delicate, and that she held her head over to the right. There was no apparent abnormality of respiration while she was awake.

On examination, a considerable mass occupied the hollow below the angle of the mandible, extending forward into the carotid triangle. The swelling was firm, and no separate glands could be differentiated.

At night, respiration was rapid and apparently difficult; but the child did not complain of discomfort, and no signs of pulmonary disease were present.

An operation was not undertaken until a month after admission, as the

FIG. 203.—GANGLIONIC TUMOUR OF THE LEFT VAGUS. High and low power.

child's general condition was not good; but since no material change occurred, it was decided to remove the mass.

On division of the skin and fascia of the neck, a number of enlarged lymphatic glands were exposed and removed; but these were found to lie on the surface of a large slightly lobulated tumour extending upwards to the base of the skull, and deeply to the wall of the pharynx.

Freeing of the deep connections proving difficult, the tumour, which was assumed to be a fibroma springing from the base of the skull, was bisected, the lower half, which was already cleared, was removed, and the upper half was snipped away from the skull with scissors. The whole tumour was $3\frac{1}{2}$ inches in vertical length and 2 inches in width.

The operation was well borne, and no difficulty was experienced either with regard to the pulse or the respiration. The child was very sick during the first night, bringing up large quantities of mucus. The next morning she was apathetic and disinclined to speak, while the voice seemed changed and deeper in tone. The pulse had risen to 160 and was small, the respirations were 28.

During the next two days the apathetic condition was maintained; the child was drowsy, and great difficulty was experienced in getting her to take nourishment. The tongue was furred, and the breath foul. Moist sounds were heard throughout both lungs. The pulse maintained a rate of 130. On the fifth day it was noted that the base of the left lung was airless. The child would take nothing but albumen water, which was supplemented by saline rectal injections. The rapidity of the pulse was maintained, and now frequent intermissions were noted. The respirations rose to 40. The temperature on this day rose to 102°.

No further change took place in the character of the symptoms, and the child gradually sank, dying on the thirteenth day after the operation.

At the post-mortem examination general septic broncho-pneumonia was present in both lungs, most marked in the lower lobe of the right lung. No further visceral disease was discovered. Examination of the tumour (*Fig.* 203) had already revealed the presence of nerve fibres and numerous ganglion cells contained in the large mass of fibrous tissue, and on tracing the vagus upwards it was found to have been completely divided, a small fragment of the tumour still remaining on the lower portion.

The occurrence of a ganglionic tumour of these dimensions on the vagus must be extremely rare, since no such cases seem to have been recorded. In this instance there were no obvious signs pointing to the nature of the tumour, and I mistook it for a fibroma springing from the base of the skull, a condition with which I was familiar. No immediate symptoms accompanied the division of the vagus, but it seems clear that it was responsible for the symptoms which developed subsequently, and led to the death of the child. In the only other instance in which I have divided the vagus, resection of an inch and a half of the left trunk at the base of the neck gave rise to no symptoms, either immediate or remote, beyond laryngeal paralysis. The nerve in that case was involved in a secondary epitheliomatous tumour of the neck. It was sutured at the time of the operation, and during the next few months there was distinct evidence of return of function in the paralyzed laryngeal muscles.

SHORT NOTES OF RARE OR OBSCURE CASES.

A CASE OF MIXED CARCINOMA AND EPITHELIOMA OF THE ANUS.

By G. H. MAKINS, London.

The patient, a man aged 72, came under observation in April, 1909, complaining of a sore at the margin of the anus which had troubled him for some months. On examination, a smooth circular ulcer was seen, involving the back and left margin of the anus. The ulcer was three inches in diameter, raised above the surface of the surrounding skin; but the whole surface was flat, covered with granulations, and there was no induration of either the margins or base of the area affected. On rectal examination the ulcer proved to extend to just within the anal canal, but the rectum above was normal.

The bowels were acting regularly with little discomfort, and the patient did not suffer with any signs of obstruction. No enlargement of the inguinal glands could be detected.

The appearance of the ulcer suggested a simple granuloma, and no signs suggestive of tubercle were present. It was dissected away readily, and preserved for microscopic examination. There was slight incontinence for some days after the operation, as a result of interference with the external sphincter ani; but the wound healed rapidly, and no further trouble was experienced.

A microscopical section of the ulcer showed it to consist of squamous epithelioma apparently invading a columnar carcinoma (*Fig.* 204).

In November, 1911, nineteen months after the operation, the patient again came under observation. On this occasion no ulceration was present; but a nodular flat tumour, covered with a smooth epidermal layer, occupied the site of the original sore. It was of a dull pink colour, and its appearance suggested a secondary growth of columnar carcinoma, such as is seen when the growth extends from a colic carcinoma to the abdominal wall.

The anus was somewhat contracted, but not enough to seriously impede defæcation, the patient's main complaint being of discomfort when sitting. A rectal examination again failed to disclose any growth above the anal canal.

The growth was not extensive, freely movable, and no enlargement of the inguinal glands could be discovered. Under these circumstances a further operation was recommended; but this was refused by the old man, who lived on until April, 1913, and died as a result of extension of the growth.

The case was remarkable in more than one particular. First, in the absence of all the clinical signs of a squamous epithelioma; secondly, in the presence of the elements of a columnar carcinoma, practically external to the anus in the absence of any discoverable growth higher in the rectum or colon.

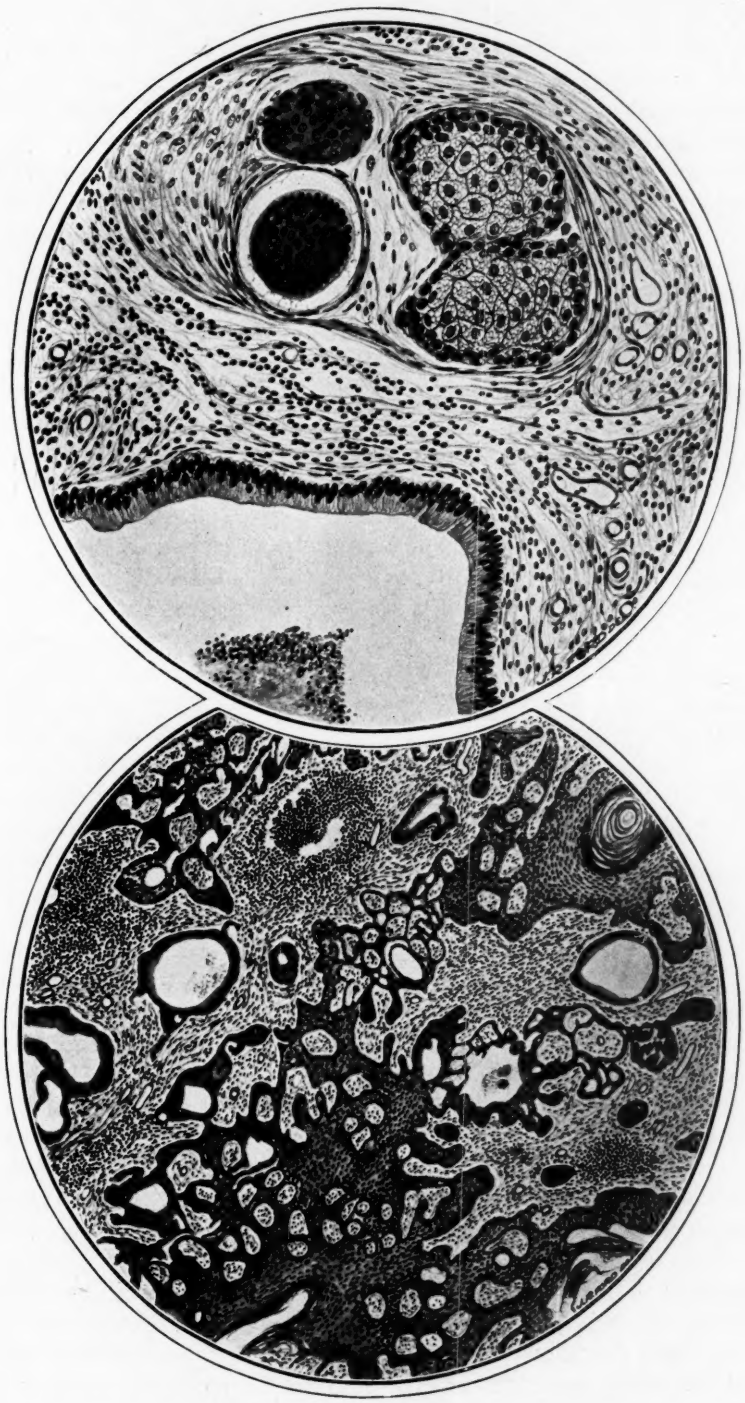


FIG. 204.—MIXED SQUAMOUS EPITHELIOMA AND COLUMNAR CARCINOMA OF THE ANUS. High and low power.

A CASE OF URINARY DEPOSIT IN BOTH KIDNEYS.

By G. P. NEWBOLT, LIVERPOOL.

I first saw Mr. C. W., aged 28, on Dec. 3, 1912. He was then suffering from acute abdominal pain.

In May, 1912, he met with a severe accident, in which his right femur and tibia were broken. The tibia remained ununited, and there was mal-union of the femur; for this trouble he came under the care of Mr. Robert Jones five months later. The limb was refractured and elongated, and fixed in a suitable splint.

On December 3, 1912, he was allowed out of bed, and it was after getting up that the pain in his right side commenced. At this time he had been lying on his back for nearly eight months. Prior to his accident he had been in the habit of taking a good deal of exercise, and was in perfect health.

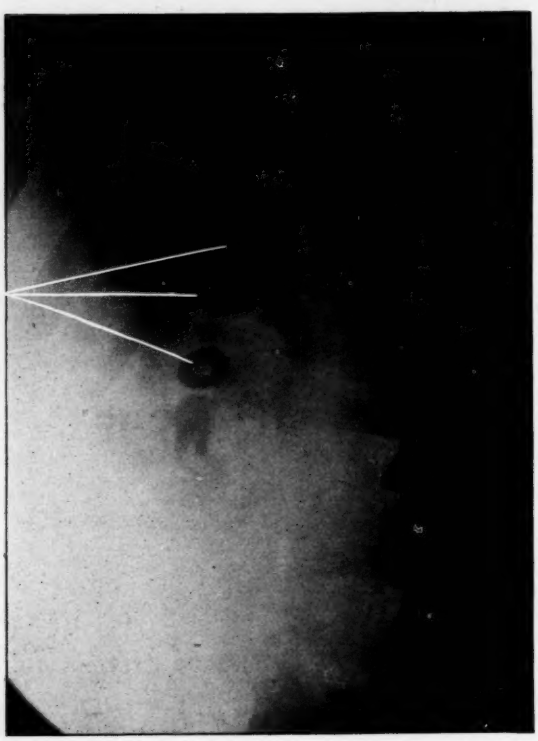


FIG. 205.—Showing stones in right kidney (A).

Dec. 3, 1912.—On examination, he complained of pain in the right iliac region, and there was a very definite tender area over McBurney's spot. There was slight pyrexia, with a pulse of 92. The bowels were constipated, and the patient was in a rather nervous condition. On keeping him in bed, the symptoms gradually cleared up, but seven days later he had an acute attack of bladder pain, and this was followed by pain in the left loin. At this time his urine was normal. On Dec. 18 several radiographs were taken by Mr. Thurstan Holland, and these showed definite shadows in both kidneys, with a very marked shadow in the left ureter. The outline of these shadows was not as well marked as that of an oxalate calculus usually is, but there was a deposit about an inch long in the left ureter, and this gave a clue to the nature of the deposit in the kidneys.

Obstinate constipation still continued, and on one occasion a large amount of mucus and some blood were passed per anum.

He was allowed up, but the attacks of pain came on each evening when he returned to bed, and were so severe that he had to have injections of morphia; there was also some sickness. On December 23, albumin appeared in his urine, with an occasional trace of blood and a few pus cells. On December 27, 1912,

he returned home to Chester, and came under the care of Dr. H. Dobie. After his journey in a motor car to Chester, he had an acute attack of pain, which required a large dose of morphia before he was relieved. He also suffered from sickness, which may have been partly due to the morphia. He was put on nitro-hydrochloric acid, aerated water, and sour milk, together with the juice of four lemons daily.

Early in January, he passed some calculous débris, which was sent up to the Clinical Research Association. The report was as follows: Urine acid, sp. gr. 1015, a small amount of albumin. Microscopical examination of the centrifugalized deposit of the urine revealed the presence of several red blood corpuscles, together with a slight excess of mucin, some scattered leucocytes, and a few epithelial cells derived from the bladder and the tract above. In addition, there were many irregularly-shaped crystalline masses which, after special treatment with hydrochloric acid, were found to be composed of aggregations of calcium oxalate crystals held together by some organic matter. These constituted the gravel present. No tube casts were detected.

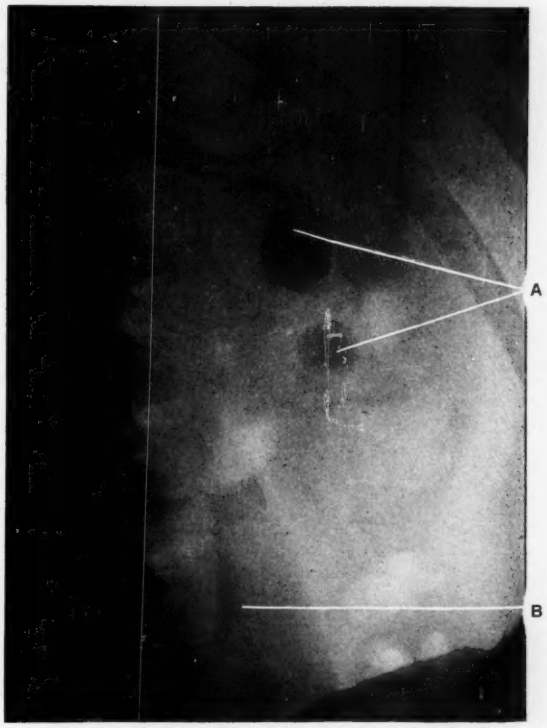


FIG. 206.—A, Stones in left kidney. B, Calcareous material in left ureter.

January 21, 1913.—I visited him at Chester. He seemed better, and was getting about, but still had attacks of pain, though he had passed no more calculous material.

March 25, 1913.—He had had no pain for three weeks, no more débris had passed, his urine was acid and contained no albumin. His weight was up to normal, and his leg much better. Radiograms taken then showed no deposit whatever in either kidney, ureter, or bladder.

When first I saw Mr. W. I thought he had an attack of appendicitis, but it was evidently mild, and as he had already gone through a good deal of suffering and was in poor condition, I determined to see if it would not clear up. The acute bladder-pain was peculiar, for though frequency of micturition and bladder pain often accompany an attack of appendicitis, yet this pain was very acute, and when it was followed by discomfort in the left lumbar region it was evident that an *x*-ray examination was demanded. At this time his urine was normal as stated above, except for its neutral reaction.

The *x*-ray examination was most interesting, for it showed definite masses

of calcareous material in both kidneys and down the left ureter. I have no doubt that the deposit formed whilst he was lying on his back, for he was quite healthy before his accident, and took a good deal of exercise. Directly he began to get up the pain commenced, and his first attack started on the first day on which he was allowed to get up after his accident, wearing a calliper splint.

Soon after his return to Chester he passed grit and organic matter, probably set free by the motor ride, for this was followed by acute agonizing pain and sickness. His treatment consisted in exercise, in spite of his pain, together with acids, morphia and sedatives being given when required.

FIG. 207.—Showing (A) Calcareous matter in left ureter.

The complete disappearance of the shadows from the kidneys in three months' time is most extraordinary.

That the shadows were not those of scybala was shown by the fact that the attacks were definitely those of renal colic. After his motor ride to Chester, half a grain of morphia was administered before the pain was relieved. In addition to this, the shape of the ureteric deposit, the passage of the calcareous débris, together with the presence of blood and pus cells in the urine, negative this diagnosis.

At present he is in good health, his urine is normal. The albumin disappeared on Mar. 18th.

I am indebted to Mr. Robert Jones for sending the patient to me in the first place, to Dr. H. Dobie, of Chester, for the later notes of the case, and to Dr. Holland for the radiographs.

The radiographs show: (*Fig.* 205) Deposits in right kidney, (*Fig* 206) Deposits in left kidney, (*Fig.* 207) Deposit in left ureter, and later ones show a complete disappearance of all these deposits.

A CASE OF AMASTIA.

By GRAHAM SIMPSON, SHEFFIELD.

Congenital absence of one or both breasts must be very rare; I have seen only the present case, and several surgeons, physicians, and gynæcologists of whom I have enquired, tell me that they have never seen an example. Sampson Handley in one of the latest text-books of surgery calls it "very rare," and gives no illustration of the condition.

The original of the photograph is a woman, aged 35, who was admitted to the Sheffield Royal Hospital under my care for an ulcer of the stomach, for which a partial gastrectomy was done; the absence of her left breast was noticed during the examination, and it was a little difficult to elicit the facts of the case and the family history, as she was rather ashamed of her peculiarity, though it is probably her one claim to distinction.

The condition is, of course, congenital, but it appears that no other members of the family are affected in the same way, nor is there a history of other congenital deformities in her relations; apart from the mental anguish of having such a blemish, the absence of the breast seems to have caused her no trouble; she has one child of fifteen, which she suckled with her right breast. Shortly after this was born, she underwent a double oophorectomy.

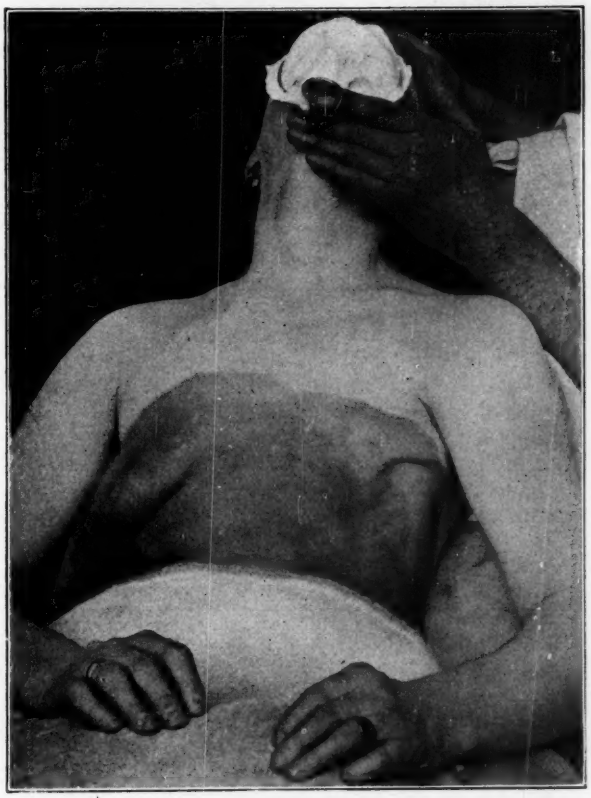


FIG. 208.

As will be seen from the photograph (*Fig.* 208), the breast is absent and there is no sign of a nipple; there is a puckering of the skin just below the anterior fold of the axilla for which no cause was found; the chest on that side is unusually flat, and the ribs can easily be felt owing to the absence of both pectorals; the movements of the arm are perfect, and, except for the absence of a scar, the condition closely resembles that seen after the complete operation for cancer.

The arm is well developed, but the left hand is much smaller than the right: the middle finger of the right hand measures four inches in length, whilst that of the left is only three inches. Unfortunately, in the illustration, the difference in the size of the hands is not as obvious as it should be, because the photographer stood on the patient's left side.

The right breast appears to be perfectly normal and is well developed, and no other malformations were found.

The dark colour of part of the skin is due to the preparation with tincture of iodine.

REVIEWS AND NOTICES OF BOOKS.

Fibroids of the Uterus: their Pathology, Diagnosis and Treatment. By SIR JOHN BLAND-SUTTON, F.R.C.S. Pp. 245, with 39 illustrations. London: Science Reviews Limited. 4s. 6d. net.

WE have read this little monograph with much interest. Those of us who are old enough to remember the days when the gynæcologist was limited in his operative treatment of fibroids to such procedures as could be carried out through the cervix, and who have followed the development of treatment through the stage of the extra-peritoneal pedicle fixed with the serre noeud, on to the safe and elegant modern operation of abdominal hysterectomy, feel that they have passed from darkness to light, and will sympathize with the author in the warm encomium with which he prefaces this volume. He says that " Hysterectomy for fibroids is unrivalled among surgical procedures for its ability to amend invalid women by thousands. It enables them to lead useful lives and, if married, to be companions to their husbands. In this sense it is one of the most beneficial operations in the whole range of surgery."

Certain difficulties and problems still remain to be satisfactorily solved ; and we are glad to note what the author has to contribute in regard to these.

He fully recognizes the difficulty of distinguishing some cases of fibroid from sarcoma. He says that the pathologist is sometimes quite at fault in attempting the discrimination. Recurrence after removal of supposed fibroids is sometimes the first proof of the malignant nature of the tumour. " No uterine operation is attended with so little success as hysterectomy for sarcoma."

In discussing the age changes in fibroids, he shows that calcified myomata are by no means uniformly harmless. The degenerative changes seen in submucous fibroids are largely due to circulatory disturbances following on strain or torsion in the pedicle. In submucous fibroids what is most to be feared is microbic infection. He compares a uterus containing a submucous fibroid to one containing a retained placenta, only the fibroid is carried for months and years, and is thus liable to be infected sooner or later, especially when the cervix becomes dilated by the attempt of the uterus to expel the tumour. He holds that bleeding from fibromatous uteri is largely due to endometric infection. The frequent association of all sorts of tubal disease with fibroids is evidence of infection. He insists on the fallacy of waiting for the menopause to cure myomata.

He considers that there is no definite effect on the heart attributable to fibroids ; but cases of valvular heart disease, if well compensated, may undergo hysterectomy, and that the cardiac condition may greatly improve subsequently. This we can confirm. As regards the relation of cancer to fibroids, he says that there is no special tendency for cancer to develop in the cervical stump after subtotal hysterectomy. His own predilection is for the subtotal operation, which he has done in about 95 per cent of his cases. He is of opinion that interstitial and submucous fibroids predispose to malignant disease of the endometrium. Among women over 50, who undergo hysterectomy for fibroids, ten per cent have also cancer in the uterus. It is the infection of cancer by micro-organisms that leads to bleeding, sloughing, and gangrene, and to the higher mortality that attends hysterectomy for carcinoma.

Fibrosis uteri is considered to be an end result of microbic infection, although he has not found micro-organisms commonly present in uteri removed for fibrosis. Adenomyoma is probably due to micro-organisms, and in some cases to tuberculosis. The cause of red degeneration is not known. If microbes are found they are but a sequence, not a cause.

It is a mistake to hold that fibroids increase in pregnancy by sharing the physiological growth of the muscular tissue in general; and the notion that they may disappear during the process of involution is "unsupported."

Some good examples are given of the rarer conditions that may simulate fibroids, such as echinococcal cysts, wandering spleen, and pelvic kidney; and of the ever-recurring fallacies created by normal and abnormal pregnancies.

As regards treatment, he declares that all medical and electrical methods of treating fibroids are conspicuous failures. He is no great advocate of the vaginal route for attacking fibroids, except in polypoid tumours and some small cervical myomata, nor does he much favour myomectomy. He believes that leaving one ovary does tend to diminish climacteric symptoms. He condemns the so-called operation of "Utriculoplasty" for fibrosis. The more difficult operations required for impacted fibroids and those invading the broad ligaments are discussed. He sometimes ties the uterine arteries as a preliminary to total hysterectomy. It seems likely that a ureter may be unconsciously ligatured, and that no special symptoms may follow to disclose the fact. Drainage by rubber tube in the abdominal wound is preferred to vaginal drainage.

He repeats the views given in his Hunterian Lecture of 1909 on the occurrence of pulmonary embolism and thrombosis in operations on the female pelvic organs. In the practice of some surgeons, fatal pulmonary embolism occurs in as much as one per cent of hysterectomies. That the chief cause is sepsis all must agree. But his contention that there is special liability to embolism and thrombosis when catgut or other sutures are buried in the abdominal wound needs more proof than has yet been adduced; and it has yet to be shown that the statistics from hospitals where abdominal incisions are almost uniformly closed with buried catgut, bear out his contention. We do not think they do. He says that gonococcal infection seems not liable to cause thrombosis.

Such are some of the points that have struck us in reading this clear, concise, and practical work. It contains many useful hints for the hysterectomist and pathologist.

The Catarrhal and Suppurative Diseases of the Accessory Sinuses of the Nose. By Ross Hall Skillern, M.D., Professor of Laryngology, Medico-Chirurgical College; Laryngologist to the Rush Hospital. Pp. 382. Fully illustrated. Philadelphia and London: J. B. Lippincott Co. Price 18s. net.

The importance of the accessory sinuses about the nose is now thoroughly realized, and constant additions are being made to our knowledge of them, so that the task set for himself by Dr. Skillern is no light one. The author has confined himself strictly to the inflammatory affections of the sinuses, and even so gives over 580 references in his 382 pages.

The book is divided into five sections: the first is devoted to general considerations, and begins with an excellent description of the anatomy of the lateral nasal walls; this description is very clear and is very fully illustrated, many of which are culled from the works of Onodi, Hajek, and others. The bacteriology is judicially discussed, and the various organisms found in sinus suppuration by different workers arranged in lists; in the most recent of these the influenza bacillus finds no place, an omission which can scarcely be accepted.

The general discussion on diagnosis presents no new feature; we feel that the use of *x*-rays should be more emphasized, and that the possibilities of stereoscopic *x*-ray photographs should have been at least considered.

The second section deals with the maxillary antrum; the anatomy again receives great attention, so much so as to tend to overshadow the rest of the section. The sources of infection are dealt with fully, and we do not think that the view put forward that infection from the teeth accounts for only 20 per cent of the cases will be generally accepted; the distinction made between infection by continuity and contiguity is somewhat subtile. The operations on this sinus, as indeed on all the sinuses, are well described and admirably illustrated, making it possible to follow each step

with the greatest ease. Cocain is recommended for all except the Caldwell-Luc operation, and the doses used strike one as very large.

The third section deals with the frontal sinus; the fourth with the ethmoid; and the fifth with the sphenoid; in all the anatomy is well described. To methods of diagnosis nothing new is added. The treatment advocated for acute frontal sinusitis is not so good as for the chronic suppurations; the author recommends removal of the anterior end of the middle turbinal before the simple expedient of opening up the fronto-nasal duct with adrenalin has been given a trial. The descriptions of the various operations are again very good, and indeed those of the intranasal operations for the radical cure of frontal sinus suppuration must be considered as forming the best part of the whole work, and perhaps, for the first time, we are given statistics of the results obtained.

Perhaps the most difficult task that faces the writer of a book on surgery is to state clearly the indications for performing any particular operation; that this difficulty is very real when operations on the sinuses are under discussion, has been realized by Dr. Skillern.

We should have liked to see more space devoted to the subjects of orbital complications; this interesting question is dismissed in a few lines. Further, in discussing meningitis following sinus suppuration, no mention is made of lumbar puncture as a diagnostic measure, nor is the treatment of this fatal complication pursued.

The book is very readable, and gives a good review of the subject; it is more than a student's text-book, and less than an advanced treatise.

A Text-Book of Surgery for Dental Students. By G. PERCIVAL MILLS, M.B., B.S.Lond., F.R.C.S., and HUMPHREY HUMPHREYS, M.B., CH.B., B.D.S. (Birm.), D.D.S. (Eng.). Illustrated. London: Edward Arnold. Price 12s. 6d. net.

THE demand for such a work has arisen from the fact that of recent years examining bodies have defined the extent of knowledge required by candidates for dental degrees and diplomas. This step has been followed in some schools by providing a special lecturer on surgery for the dental students, an arrangement which has everything to commend it. The work now published by Mr Mills and Mr. Humphreys may be safely recommended to those for whom it is written, as in every way sufficient for their requirements at the various examinations at which they present themselves, and as a well thought out and clearly written work on surgery so far as it concerns them. The early chapters are on surgical bacteriology, infection immunity, and inflammation. These subjects are dealt with simply, but yet to a sufficient extent to enable a student to gain a working knowledge of the general principles underlying them, and to note their importance as an introduction to the study of surgery. The scope of the work is limited to the subjects in the syllabus of the Royal College of Surgeons of England, but these are treated in a most careful and thorough way. Full consideration has been given to the treatment of those diseases which are usually dealt with by the dental surgeon, and in other cases only the general principles of treatment are indicated. Fifty-six well-drawn illustrations, mostly original, add to the value of the book. The print and general get-up are excellent. We are confident that this book will meet a real requirement, and that it will prove of great value to the dental student.

SIR ASTLEY PASTON COOPER, Bart.

1768–1841.

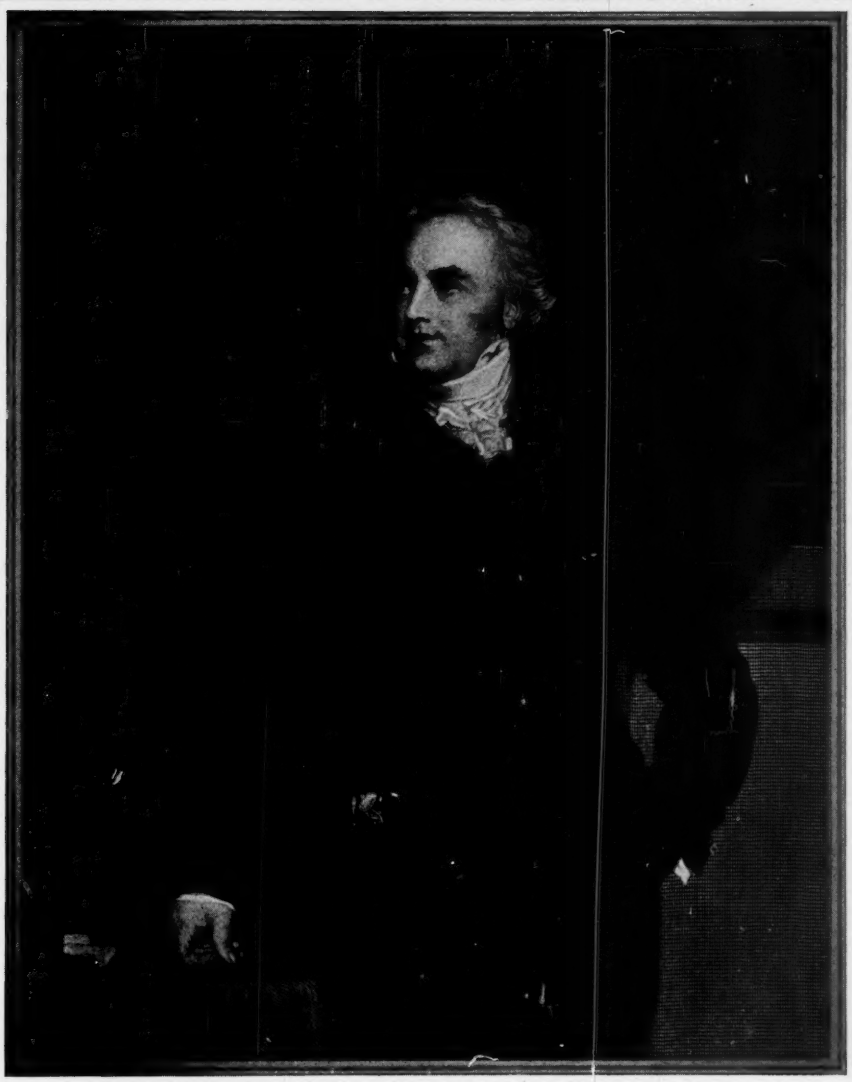
THE fourth son of a Norfolk vicar whose father and brother had been surgeons Astley Cooper's career shows the possibilities of attaining to rank, fortune, and a European reputation which exist in the profession of medicine. Born near Norwich in 1768, of parents in easy circumstances and some literary talent, he passed a spirited boyhood without much schooling. At the age of sixteen he was apprenticed to his uncle, William Cooper, then surgeon to Guy's Hospital, but his indentures were soon transferred to Henry Cline, surgeon to St. Thomas's Hospital. Cooper soon showed himself an accomplished practical anatomist. He loved to teach and to argue, and at the early age of twenty-one he was appointed demonstrator of anatomy at St. Thomas's, and two years later Cline associated him with himself as lecturer on the subject, which then included surgery. The students of the United Borough hospitals came to him in crowds, and his ability, bonhomie, and obvious sincerity of purpose made them his fervent admirers. By their means he soon obtained a very large share of the consulting and operative practice in and near London. Full of energy, he always rose early and, even when he was in full practice, made it a rule to dissect for an hour or two before breakfast, at first pure anatomy, and later in life, pathological specimens. The knowledge of anatomy thus gained made him a safe operator, whilst practice rendered him confident and skilful. His memory for cases was remarkable, and he thus excelled in diagnosis. Like John Hunter, whose lectures he had attended, he was a firm believer in the effect of personal intercourse in promoting the advance of professional knowledge. He took an active part, therefore, in founding the Medico-Chirurgical Society, of which he was the treasurer in 1805. The first paper in the first volume of the Transactions is from his pen. It is a case of aneurysm of the carotid artery treated by the application of a double ligature on the proximal side. Cooper wrote much, and his treatise on hernia—a defect of which he had experience in his own person—as well as his treatise on fractures and dislocations, served as a basis for modern advances in both subjects: they would have proved more valuable had some reference been made to the work of other observers.

It is clear from all accounts that Astley Cooper owed much to his personality; thus Mr. Travers, one of his apprentices, speaking of him as he was in the year 1800 says: "Astley Cooper, when I first knew him, had decidedly the handsomest, that is to say the most intelligent and finely-formed, countenance and person of any man I remember to have seen. He wore his hair powdered, with a queue, then the custom, and having dark hair and always a fine healthy glow of colour in his cheeks, this fashion became him well. His frequent costume during the summer when taking horse exercise (for at this season he rode daily on horseback), was a blue coat and the yellow buckskin breeches and top-boots then much in vogue. There was a fine and quickly-responsive animation in his eye, and, though he was of full height, the outline of his frame was muscular and flowing without any approach to corpulency." He spoke with a Norfolk accent to the last.

He was twice married, the first time, in 1791, to Miss Anne Cock, the only daughter of a Hamburg merchant, who brought him a fortune of £14,000. The only child of the marriage was a daughter, who died of tuberculous meningitis in her infancy, to the lasting grief of her mother, who seems never afterwards wholly to have recovered her spirits. The baronetcy conferred upon Cooper after he had operated upon King George IV for a tumour of the scalp, went by special remainder to an adopted nephew. As an instance of the change in surgical practice, it is told of this operation that Cooper was summoned hurriedly to the palace one evening, and on his return he asked Bransby Cooper, his nephew, " Pray tell me, do you see anything particular about me, for the king did not seem in good tune ; he looked very hard at me from head to foot, and I cannot understand why—do you see anything ? " " Why," said Bransby, " I should have put on a white cravat and a clean shirt, or at least have washed my hands before I waited on His Majesty." The fact is, Sir Astley had performed a slight operation just before he went to the palace, by which some blood had stained the sleeve of his shirt where it projected at the wrist, and his hands also were not perfectly free from it. Mr. Cooper, then looking at what I had pointed out to him, said, " God bless me, so I ought, but I was not aware of it. The King, sir, is a very particular person ; he was lying on a couch under a canopy with a red turban on his head, and he looked displeased, and now I see the reason of it."

In 1824, quarrels arose at the United Borough Hospitals about the right of lecturers to sell the goodwill of their lectures to their successors. The quarrels centred round Dr. Addison and Sir Astley Cooper. They ended in a formal separation of the two schools, Guy's Hospital Medical School being opened as a separate institution in 1825. It quickly became successful, owing to the prestige of Sir Astley Cooper, and the St. Thomas's Medical School underwent a corresponding decline. Sir Astley Cooper was twice President of the Royal College of Surgeons of England, in 1827 and again in 1836. He retired from practice for some years before his death, and lived at Gadebridge, near Hemel Hempstead, in Hertfordshire, where he followed the pursuits of a country gentleman. Here he died on February 13, 1841, and was buried in the chapel of Guy's Hospital. A statue to his memory stands near the southern entrance to St. Paul's Cathedral, and its pedestal gives the date of his death incorrectly as 1842.

Sir Astley Cooper was a first-rate anatomist, a bold surgeon, and a kindly gentleman, at a time when anatomy, surgery, and humanity were at a low ebb amongst the medical profession in London. The boldness of his surgery is shown by his ligature of the abdominal aorta, and by his amputation through the hip joint, at a time when these operations had not been previously performed, and when anæsthetics were as yet unknown. Contemporary evidence shows him to have been an operating surgeon of a high order, although, like many surgeons in the pre-anæsthetic days, he says that " he felt too much before he began ever to make a perfect operator." Quickness of perception was his forte, for he saw the nature of disease in an instant, and often gave offence by pouncing at once upon his opinion. The same faculty made his prognosis good. He had an excellent and useful memory. In imagination he was vivid. His principle in practice was never to suffer any who consulted him to quit him without giving satisfaction on the nature and proper treatment of the case.



SIR ASTLEY PASTON COOPER, Bart.

Reproduced from the Painting by Sir Joshua Reynolds

CONGENITAL ENLARGEMENT OF THE COLON AND RECTUM.

By L. E. BARRINGTON-WARD, London.

The first full description of this disease was given by Hirschsprung in 1896, and it has been customary to associate his name with the condition. It had, however, been recognized before that date, and according to Jayle, Ruyson in the 17th century described a fairly typical case in a girl of five years. Parry in 1825, Billard in 1829, Von Ammon in 1842, published undoubted cases, which were followed by several others before Hirschsprung's paper appeared (Finney).

The disease, when developed, presents such a striking picture that it is not surprising to find that observers hasten to put their experiences on record, and the literature of the condition is considerable. Finney, in a comprehensive survey, discovered 206 references up to January, 1908, and gave an excellent summary of its chief points. I have found his paper of considerable value in the preparation of this thesis, and have read all those articles which influence the point of view from which the subject is here approached, and all other accessible communications which have been made up to the present date.

The clinical features are well known, and it is not proposed to deal with that section at any length. Etiology and treatment offer a wider scope.

For the purpose of enquiring into the etiology I have taken the post-mortem records of all the cases of this nature at the Hospital for Sick Children, Great Ormond Street.

Inasmuch as in the records the old nomenclature of sigmoid colon and rectum was used, I have thought it advisable, in order to avoid confusion, to retain this description of the large bowel as far as possible, in preference to the newer division into iliac and pelvic colon and rectum

It is undoubtedly common to label as Hirschsprung's disease many conditions which are not so. Many of the recorded cases, especially of elderly males, are probably instances of an advanced degree of fæcal stasis: I have seen two or three such instances in infants, in which fissures about the anus caused a reflex spasm of the sphincters and prevented defæcation. With the onset of abdominal distention and vomiting, the diagnosis of Hirschsprung's disease was suggested. Treatment, viz., dilatation of the sphincter, at once differentiated this spurious form from the true variety. Post-mortem examination or operation is a certain test, and I have accordingly limited myself to cases verified by these means.

What is the best treatment to employ is still an unsettled question. I propose to give in some detail the treatment of five recent cases for which in three instances I was partly responsible, and in which the results have surpassed any others that have been treated at the Children's Hospital, Great Ormond Street.

Definition.—The disease is perhaps most generally known by the name of *Congenital Idiopathic Dilatation of the Colon.*

Cases where any form of obstructing agent is demonstrable should be excluded. In its most typical form, congenital enlargement of the colon is manifested by progressive constipation and intestinal distention dating from birth. A form of the disease was described by Hirschsprung, which occurs in later years, and has been given the misnomer of pseudo-megacolon. Many of the cases described as such are not true examples of congenital enlargement, but are due to various kinds of mechanical obstruction, and some to simple stasis. That the true congenital disease may occur in later life must be admitted, but such instances are rare and are in every way comparable to the occasional appearance of apparently typical cases of congenital pyloric obstruction in adult life.

Emphasis is usually laid on the dilatation of the intestine. The hypertrophy, however, is no less striking a feature, and has been described as present

FIG. 209.—*Case* 17. The huge size of the colon is well shown.
(Photo by G. B. Wainwright.)

at birth (Billard, Joukovsky). If this is a secondary hypertrophy it is necessary to assume that there is an intra-uterine factor at work. Further attention will be paid to this point in discussing the etiology.

It is described as a disease of the colon, and the sigmoid colon has attracted most attention. The huge sigmoid is undoubtedly a feature of the condition, (*Fig.* 209), but I shall hope to show that it is not necessarily in the colon that the most marked changes are found.

It is the function of the sigmoid to act as a reservoir for fæces, and in virtue of its wide mesentery its capacity for distention in the normal is considerable. Therefore, in any distention affecting the large bowel as a whole, the change will be most marked in the sigmoid.

Observations as to the condition of the rectum proper in these cases are often incomplete. Of fifteen of my cases in which a definite examination of this part was made at autopsy, in thirteen the rectum was noted as dilated and

hypertrophied to the anus. In four cases during life this has been suggested by radiograms after bismuth meals and has been verified at operation.

It must therefore be conceded that the term congenital dilatation of the colon is incorrect in that it does not express the hypertrophy that so constantly accompanies the dilatation, and does not include the rectum, which in many of these cases shows the most interesting changes. Congenital enlargement of the rectum and colon more accurately expresses the condition of affairs.

Etiology.—Finney has made a complete collection of the numerous theories that have been put forward in explanation of this disease. They may be classified under the headings of *mechanical*, *neuropathic*, *inflammatory*, and *congenital*. To say that the condition is congenital is of little assistance; it merely means that it is an error of development which our present knowledge of pre-natal pathology is insufficient to explain. Yet it will be of some assistance to determine whether the disease can come under this heading, or whether it is due to some factor acting post-natally which may be controlled by the methods at present at our disposal.

It has been suggested that the cause may be :—

A. Mechanical :—

1. An abnormally long mesentery permitting torsion of the sigmoid (Barth)
2. Increased length of the intestine, especially the sigmoid, which throws the bowel into loops, and causes kinking and obstruction (Marfan, Neter)
3. Atresia of the rectum and anus (Treves)
4. Valve formation (Perthes, Roser)
5. Distention of pelvic colon with meconium at birth and valve action (Wilkie)

B. Neuropathic :—

1. Neuromuscular defect of a segment of the intestine (Hawkins)
2. Paralysis of a segment of intestine (Pennato)
3. A lesion of the sympathetic (Bing)
4. Reflex spasm of the sphincters due to anal fissures (Fenwick)

C. Inflammatory :—

Colitis becoming chronic.

D. Congenital :—

1. Anomaly of development—dilatation and hypertrophy congenital. (Hirschsprung)
2. Dilatation congenital, hypertrophy secondary (Mya, Concetti)
3. Hypertrophy congenital, dilatation secondary (Fenwick, Genersich)

These theories will be considered in the light of this series of cases, briefly summarizing the main points discovered at post-mortem examination.

A.—Between the years 1868 and 1912 post-mortem examinations were made at the Hospital for Sick Children on 19 undoubted cases of Hirschsprung's

disease. Of these 16 were males and 3 females. The youngest was 3 weeks, the oldest 12 years old. Ten of them were 1 year of age and under, and six between 1 and 5. Thirteen had received medical treatment; six had undergone surgical operations.

In all cases it was noted that the sigmoid colon was hypertrophied. In twelve cases the rectum was affected, either hypertrophied, or dilated, or both: in two it was said to be normal; in five cases no statement was made as to the condition of the rectum. In no case was any mechanical obstruction to be found, though in one the bowel was said to be kinked as it turned into the pelvis.

I would lay particular stress on the condition of the rectum in these cases. In many of the reported cases the rectum is said to be normal, but in the routine autopsy the bowel is not dissected out entire, down to and including the anus, but is cut across at an accessible point in the pelvis. In this manner hypertrophy of the rectum without much dilatation could easily be overlooked.

In ten cases of this series it is definitely stated that the hypertrophy of the rectum extended down to the anal canal. These are independent observations of a number of different pathologists extending over a period of forty-four years. Assuming this to be a common feature, it at once excludes many of the suggested theories. In several of the cases it is stated that the thickening of the walls of the gut became progressively greater towards the anus. No external or internal factor of any kind was found to act as an obstructing agent. The fault must have been in the wall itself. The anus was in every case normal. In three cases, a thickening was to be felt just above the anal canal, and the observers likened it to the feel of a congenital hypertrophic pylorus. In these circumstances any theory as to a mechanical cause, whether it be kinking of the gut, torsion of the sigmoid from an abnormally long mesentery or from abnormal length of the gut itself, is untenable. The last part of the rectum takes a practically straight course before passing into the anal canal, and in none of these cases was any abnormality to be discovered in the valves of Houston.

B.—The neuropathic theories are difficult to prove or disprove. Histological changes in the sympathetic are not easy to show, although Finney states that in two cases he found apparently healthy ganglion cells in both Meissner's and Auerbach's plexuses.

C.—The age, the marked sex preponderance, the history that in all but three of the cases (the time of onset in these cases was 2 months, 6 months, and 3 years 9 months), constipation had dated from birth, appear to my mind almost conclusive proof that the condition is, for want of a better term, a congenital one. Finney brings forward from the literature strong evidence in favour of Hirschsprung's conception of the disease. Several cases are on record of its being present at birth. Joukovsky describes a case which is I believe the key to the whole question. It was that of a new-born child with ectasia of the large intestine, with hypertrophy of the whole of the intestinal tract, and with stenosis of the duodenum.

If such an error can take place in the development of the whole of the intestine, it is not unreasonable to assume that it may with more frequency affect only a part of the intestine. Errors of development are especially prone to occur in the region of the junction of the proctodæum and hind gut and the junction

of the fore and mid gut. In this connection the similarity of congenital pyloric stenosis to congenital disease of the colon and rectum is striking.

The close similarity of the age of onset, the sex incidence, and the histology, well deserve examination. Both conditions may be present at birth. I have seen a perfect example of hypertrophic stenosis of the pylorus in a male infant of three days; this case was admitted to the Hospital for Sick Children under the care of Mr. Tyrrell Gray, on September 20, 1912, with a history of persistent vomiting. The diagnosis of a high intestinal obstruction or atresia was made, and at operation a markedly thickened and stenosed pylorus was discovered. The infant succumbed, and at the autopsy this condition was verified.

Characteristic symptoms of pyloric stenosis occur at about four to six weeks after birth, and the symptoms are probably due to the associated gastritis from gastric stasis and fermentation, and it is not until infection of the mucous membrane occurs that vomiting becomes a feature. Successful medical treatment—lavage—is directed to the cure of the gastritis.

In the case of Hirschsprung's disease, at first the symptoms are of constipation only and little harm results. It is with the onset of colitis at about the second or third month that characteristic and harmful symptoms develop. Fermentation changes increase the abdominal distention which, as a rule, attracts attention at about this time.

Again, in both conditions symptoms may be delayed to later life. Barling has reported instances of apparently true congenital hypertrophic stenosis of the pylorus in two patients aged 17 and 27 years. In neither case had symptoms been shown in childhood.

Congenital disease of the pylorus and colon may be theoretically explained by assuming a nerve lesion which places a block on the intestinal canal in these regions; but in view of the condition having been found at birth, it is necessary that movements of the intestinal canal should have been active for some time pre-natally. The nerve lesion, if there is one, is more likely to be of a trophic nature in the failure of regulation of the growth of the parts. We know so little of the control of the development of the body that it is perhaps idle to speculate.

Gigantism or asymmetrical overgrowth of the extremities and different parts of the body, has long been recognized, and there seems no reason why such pre-natal overgrowths or potential overgrowth should not be allowed in the case of the intestine. Finney, in the description of his own case, draws attention to the large size of the blood-vessels and lymphatics, and compares it to a lymphangiectasis such as is met with elsewhere.

Most observers are agreed on the histological changes. In those of the present series which were submitted to histological examination, the hypertrophy and hyperplasia of the muscular coats—especially the circular—were the characteristic features. Changes in the submucosa and the mucosa were of the nature of round-celled infiltration, such as would be expected from the generally associated colitis.

A satisfactory theory that will explain all the cases that have been reported as instances of congenital megacolon is impossible. Many of these cannot properly be classified as congenital colon disease at all. I believe the theory that best explains this series of cases is as follows:—

There is a congenital abnormality in the lower end of the hind gut which takes the form of a muscular hyperplasia. It usually involves the rectum and extends for a varying distance up the pelvic and iliac colon. It may be that the whole of the hind gut is affected. In some cases there is a definite localization of the change, e.g., *Cases* 2, 12, and 14, where the hyperplasia has affected a segment of the intestine chiefly. The hyperplasia of the muscle gives rise to both thickening of the walls and increase of the lumen. The physiological functions of the intestine are in abeyance, a block is produced, and the bowel behind, for a varying distance depending on the extent and duration of the condition, dilates and hypertrophies. This fæcal stasis in time produces inflammatory changes in the mucosa, and an ulcerative colitis occurs which is the cause of death in most instances.

FIG. 210.—Specimen from *Case* 1, consisting of the lower part of the rectum and anus, with the ileum entering it above. The dilated rectum has been opened to show the great hypertrophy of its wall. The patient died three days after operation. At the post-mortem, healing was advanced both where the ileum had been inserted and where the rectum had been cut across, and no leakage had occurred.

The Clinical Features are distinctive.—The salient points are intractable constipation and enlargement of the abdomen. The constipation in fifteen out of eighteen cases dated from birth. In one case no note as to this fact was made. The enlargement of the abdomen has been met with at birth. In these cases it was most commonly noted between the second and fourth month, that is to say, at a time when the colitis was appearing. If the child survives to any age, the distention may assume enormous proportions. The literature abounds in examples of prodigious enlargement.

In a few cases compensation may be established, and the symptoms are not sufficient to bring the patient under medical observation until some years have elapsed.

Of the nineteen cases, ten were 1 year of age and under, and six between the ages of 1 year and 5 years.

As a rule, diarrhœa begins sooner or later, and alternates with the constipation. Some cases remain comparatively well for periods between attacks

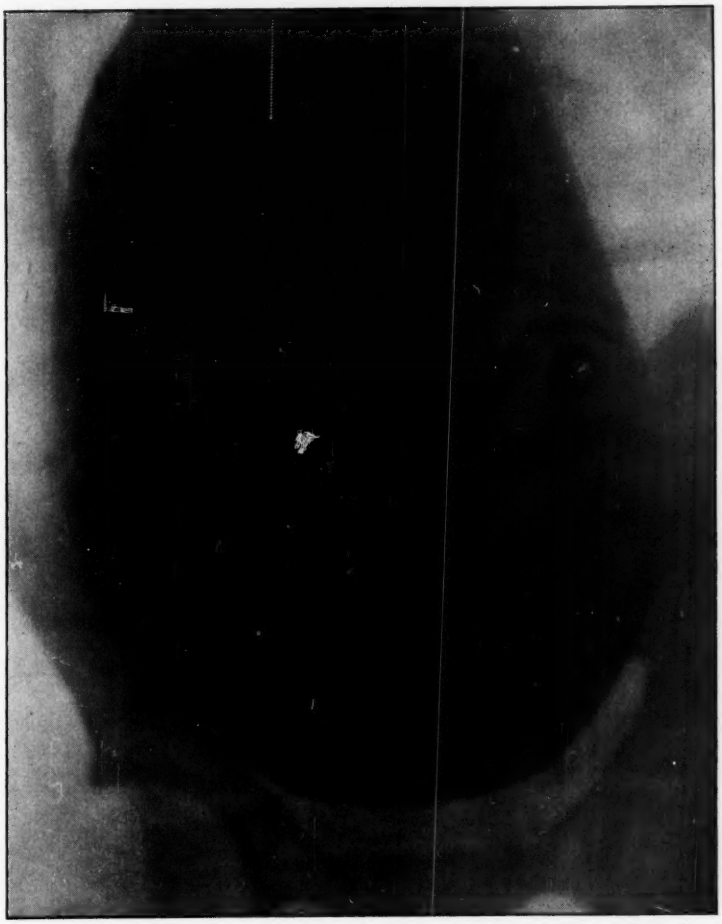


FIG. 211.—Radiogram of *Case* 1, 152 hours after a bismuth meal. The enormous size of the rectum is well seen.

of constipation and diarrhœa. It seems that compensation can break down and again be re-established. Any one of these attacks may be fatal. However well the patients appear between the attacks, purgative medicines and enemata are always required. Long intervals of time may elapse between the actions of the bowels. In one of my cases, three weeks was the usual interval, but many more striking instances have been recorded.

Abdominal pain sometimes occurs, but generally not until the later stages.

Vomiting is not a common feature, but one of these cases died from incessant vomiting at the age of three weeks.

The general features of auto-intoxication are well marked. Staining of the skin, emaciation, lethargy, foulness of the breath, a low blood-pressure, and coldness of the extremities, are present in every case of any standing.

The distended intestines produce pressure effects on the abdominal contents, and œdema of the legs, ascites, and collapse of the bases of the lungs result. One case had hydronephrosis.

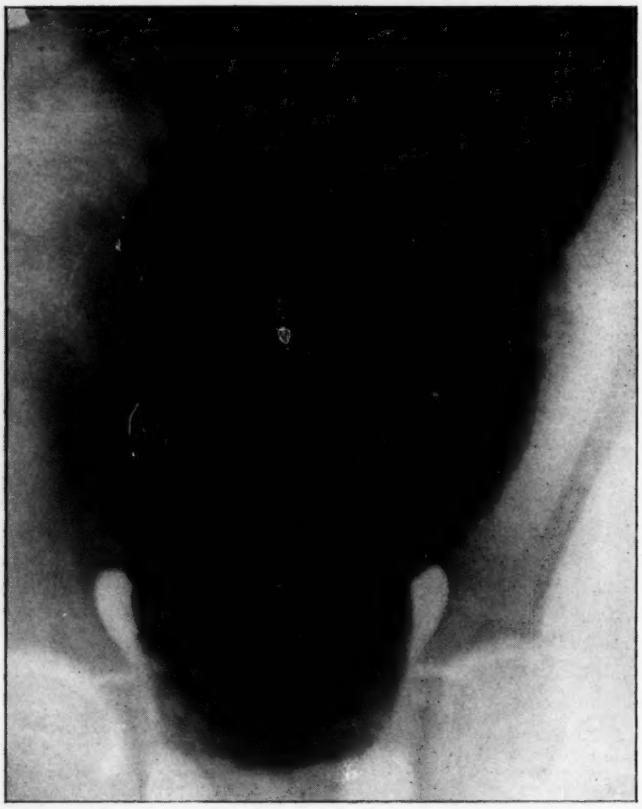


FIG. 212.—*Case* 2. Radiogram 52 hours after bismuth meal, showing dilated rectum.

The abdomen is tense, the abdominal wall has a glazed appearance and is marked by dilated veins.

Peristalsis, especially in infants, is generally obvious. On palpation, the tension may be such that nothing definite can be felt, or the fæcal masses may be distinctly palpable and may give rise to the erroneous diagnosis of abdominal tuberculosis. In favourable cases the distended segment of the intestine may be actually palpated.

On rectal examination the anus and sphincters are normal. In three cases where I have had the opportunity of performing this examination, the examining finger easily palpated the distended lower part of the rectum, which was filled

with tenacious fæcal material. I was unable to satisfy myself that I could feel any thickening of the rectal wall. In one case later, autopsy revealed enormous thickening of the rectal wall right down to the anus (*Fig.* 210).

Diagnosis.—This is easy in typical cases. Stress should be laid on the history, the constipation, and the abdominal enlargement.

A digital examination of the rectum and anus will exclude spasm of the sphincters, and simple atresia of these parts.

FIG 213.—*Case* 3. Radiogram of pelvis, showing the size of the rectum 84 hours after bismuth meal.

The matted form of abdominal tuberculosis bears at times a superficial resemblance.

Excellent confirmatory evidence is obtained by examination with the *x*-rays after a bismuth meal. Appended are radiograms of the pelvic colon and rectum in three cases (*Figs.* 211, 212, 213).

Treatment.—The treatment of this disease has been unsatisfactory, as is shown by the variety of the methods that have been employed from time to time.

In the first place it is necessary to decide the relative value of medical and

surgical treatment. The consensus of opinion seems to be that surgical treatment offers the greater hope. If the condition is at all established, it is difficult to see how medical measures can help. Drugs rapidly lose all their power on the inert bowel; enemata are generally retained, or returned without effect. The rectal tube is uncertain in its action, and can only be a temporary expedient.

In two cases, courses of pituitary extract (hypodermically), hormonal (splenic extract), and suprarenal extract, were given without the least effect.

Several writers have collected figures showing the relative mortality of cases treated medically and surgically. Duval gives a mortality of 74 per cent with medical and 34 per cent with surgical treatment. Lowenstein in fifty-nine cases dealt with on medical lines found the mortality 66 per cent, whereas of forty-four treated by surgery the mortality was 48 per cent. Terry collected 110 cases treated surgically, with a mortality of 25 per cent.

It is therefore justifiable to say that surgery holds out better prospects of recovery than medicine, and a fair estimate of the surgical mortality would appear to be about 36 per cent.

If the condition is a congenital malformation, medical measures can hardly have any curative effect. Cathartics may cause occasional evacuations by irritation; enemata may wash out any fæcal material lying in the lower part of the rectum; but neither cathartics nor enemata can restore the hyperplastic and hypertrophic bowel to its normal size, or reinitiate the normal peristalsis. The prolonged use of drastic purgatives, especially in infants, is dangerous. Many of the cases of this series were brought to hospital by the parents because of abdominal enlargement and constipation. In other respects they were fairly well. After a few days in hospital their condition became suddenly worse, diarrhœa set in, and collapse and death followed. This was in all probability due to the efforts of the physicians to clear the bowels with purgatives, which incidentally set up a fatal colitis. Post-mortem examination in these cases showed ulceration of the mucosa.

Other measures, such as massage, dieting, electricity, can only have a temporary effect on cases of undoubted Hirschsprung's disease: they may have a curative effect on the simple constipation of children.

The surgical treatment has been most varied. Cheadle claimed to have cured a case by simple puncture of the colon through the abdominal wall. The method is not likely to commend itself to most surgeons. Simple laparotomy has been performed, and the contents have been squeezed out of the anus, with temporary relief. This procedure has a field of usefulness as a preliminary to other treatment, but cannot be considered as a curative measure. Colostomy has been a favourite mode of treatment, but young children stand colostomy badly, and it is open to question whether death would not be preferable to an artificial anus acting throughout adolescence and adult life. Colostomy has been of use as a preliminary to other measures. Appendicostomy has not been followed by permanent good results.

Colopexy, coloplasty, colonplication, have all been attempted and have been abandoned. The basis of this form of treatment is founded on an incorrect idea of the pathology.

Intestinal exclusion by a short-circuiting operation is an excellent temporary and preliminary form of treatment.

The ideal form of treatment is the removal of the whole of the affected bowel down to the anus (*Fig.* 214). Treves made a complete excision of the anus, rectum, and descending colon, and brought the transverse colon to the perineum. He hoped that control would be regained later. The operation is rendered easier if the last part of the rectum is retained, and the final results justify its retention.

As the problem of treatment is frequently presented in the first few years of life, such heroic measures would be doomed to failure. In young children the operation should be performed in two stages. At the first operation the ileum is divided and implanted as low down in the rectum as possible. The open pelvis of the child permits the junction to be made at a lower level than would be possible in the adult. The junction has to be made with the greatest care, as the tissues of the rectum do not lend themselves to ready manipulation, and the risk of leakage and peritonitis is considerable.

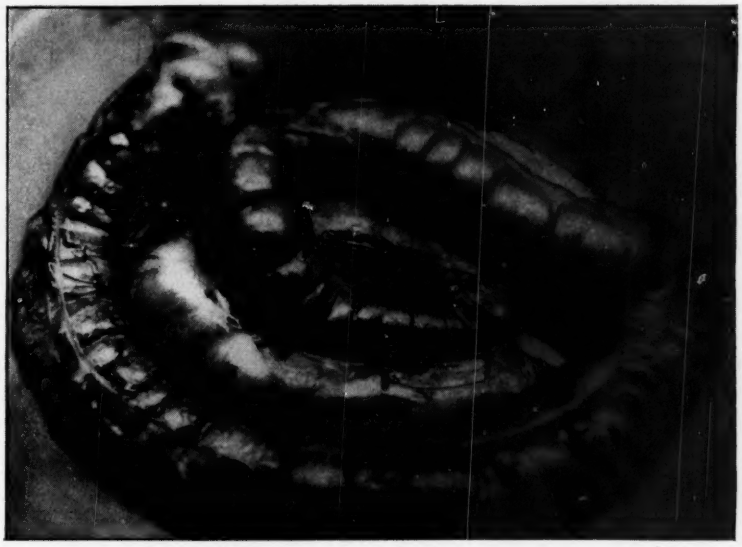


FIG. 214.—Large intestine successfully removed from a boy, aged 6, the subject of Hirschsprung's disease. (*See Case* 2.)

This operation may give the patient relief for several months. The fluid contents of the ileum find a ready exit through the shortened rectum, and the blocking of the colon and rectum above prevent regurgitation to any harmful extent. The child's strength improves, and at a favourable opportunity, some months later, the large bowel above the anastomosis is excised.

The operation may be a very simple one. This is especially the case if the gut is large and is provided with a distinct mesentery, and the vessels can be controlled in a series of pedicles. The operation is more difficult if the huge size of the bowel has encroached on the mesenteric interval.

The operation leaves the patient with the ileum entering the dilated terminal portion of the rectum. It is true that this must be considered a theoretical disadvantage, but in practice we have found that the fluid contents of the small

intestine do not tend to lie in the rectum to any extent, the control is good, and the bowels move normally after this operation. If the fæces do tend to collect, which is rare, it is an easy matter to wash out the relatively small cavity left so near the anus. (*See Fig.* 210.)

None of the cases treated are of sufficient standing to decide positively whether the ileum will dilate above the new anastomosis; but with constant care to keep the rectal sac empty this should not occur.

In some favourable cases it may be more satisfactory to complete the operation in one stage. More particularly will this be the case when the patient is of some age and in good condition, and when the size of the colon is such that the reposition of the abdominal contents would be difficult and would waste valuable time. The secret of success in these operations is speed. The shock is surprisingly small, and varies directly with the exposure of the patient and the amount of anæsthetic employed. Open ether anæsthesia should be used in all cases.

Saline subcutaneous infusion during the operation and for thirty-six hours afterwards is invaluable.

Treatment on the lines indicated has been employed by Sir Arbuthnot Lane on five patients during the last year. Four have made perfect recoveries, and the fifth died as the result of an unfortunate accident, namely, the slipping of a ligature, but for which I believe he would have made a good recovery. Their ages were 3, 6, 9, 10½, and 12 years; they were all instances of the disease in an extreme form, and they had all failed to react to medical treatment employed over long periods.

Case 1.—R. L., male, aged 12. Was admitted to the Hospital on August 18, 1912. He had had difficulty with his bowels all his life, and had never had a motion without medicine and injections. The abdomen had gradually become more distended. He occasionally had abdominal pain. Three weeks was the usual interval between the motions. He was a well-developed but thin boy, with the usual signs of intestinal toxæmia. The abdomen was very large, and was so tense that nothing definite could be palpated. On rectal examination, the finger passed into a huge cavity filled with fæces. Enemata produced no result. A bismuth meal and radiograms showed enormous distention of the colon and rectum (*Fig.* 211).

On October 1, Sir Arbuthnot Lane operated. On opening the abdomen, the pelvic colon eight inches in diameter presented. The ileum was divided and the proximal end implanted low down into the beginning of the rectum. The pelvic colon was then cut across above the junction, and the entire large bowel removed. The vessels of the colon were of a remarkable size. The operation had practically been completed, and had been exceedingly well borne, when an alarming hæmorrhage took place from slipping of the ligature on the left colic artery. It was controlled with great difficulty, and the patient lost much blood. His condition became at once grave, but improved with intravenous saline. Unfortunately, he never rallied from the severe hæmorrhage, and died on the third day following operation. Post mortem there was no peritonitis. All the parts were healing satisfactorily. The rectum was found to be enormously hypertrophied, more so than the pelvic colon (*Fig.* 211).

Case 2.—E. W., male, aged 6. Transferred from a medical ward on October 24, 1912. He had been constipated since birth, but symptoms had become more troublesome during the past year. Medical measures had failed to relieve him at all. His abdomen was distended. The enlarged colon and rectum could be palpated, and were rendered evident by bismuth radiograms. On October 25, Sir Arbuthnot Lane divided the ileum and implanted the proximal end into the upper end of the rectum.

He was greatly relieved by this operation, and for some time passed normal stools, but the tendency to constipation returned, and on February 4, 1913, the entire large bowel down to the rectum was excised. There was practically no shock, and he made a perfect recovery. His bowels have been acting normally since the operation.

Case 3.—H. B., male, aged 10½. Admitted on January 3, 1913. He had always been constipated. Had never had proper control of his bowels since infancy. At times the abdomen was very large. The abdomen was exceedingly tense and protuberant. There was tenderness in the left iliac fossa. On rectal examination, a very dilated rectum was palpated. The bismuth radiogram confirmed this, and showed great enlargement of the transverse, descending, and pelvic colon. On February 28, Sir Arbuthnot Lane excised the large intestine and implanted the ileum into the rectum. Recovery was excellent, and one month after operation defæcation was normal.

Case 4.—(I have to thank Dr. F. N. G. Starr, of Toronto, for the notes of this case). R. H., male, aged 3. Admitted to the Hospital for Sick Children, Toronto, on October 21, 1912, with the complaint of constipation dating from birth. He had showed signs of constipation when three days old, and had had no bowel movements for as long as three weeks at a time, in spite of frequent enemata. The abdomen was very distended. On Nov. 6, 1912, Sir Arbuthnot Lane removed the large intestine and anastomosed the ileum to the lower part of the pelvic colon. He made an excellent recovery.

On December 8 it is noted that the remaining part of the pelvic colon had dilated and the abdomen was slightly distended. On January 10 he was discharged. A note made on May 27, 1913, says, " Is running around the streets. Has good bowel movements every day. Has a brother two weeks old with the same condition, which started on the second day of life, and is said to be a more severe form of the disease than that from which the patient suffered." I have since heard that this last case died at the age of 15 days " from intestinal toxæmia, the result of Hirschsprung's disease." The cases have been reported by Dr. H. T. Machell in the *Canadian Journal of Medicine and Surgery*, June, 1913.

Case 5.—J. H., male, aged 9. Admitted to the Hospital for Sick Children, Great Ormond Street, on May 3, 1913. The abdomen had been distended for four years and the condition was becoming worse. He had suffered from severe attacks of pain and vomiting. He had had no diarrhœa. He suffered from constipation, sometimes having no action of the bowels for ten days. He had some retention of urine. There were five other children in the family, all healthy. The abdomen was distended and peristalsis was visible. The distended large intestine was palpable. On rectal examination, the finger passed into the dilated rectum. The *x*-ray examination showed much stasis and a very dilated sigmoid.

On June 9, Sir Arbuthnot Lane removed the descending and pelvic colon and implanted the cut end of the colon into the side of the rectum. Recovery was satisfactory. On July 28 the boy was much improved in health. The abdomen was flat. He was taking paraffin, and the bowels moved normally each day.

It may be objected that these five cases were of an age suitable for operative measures, and that the means employed could not cope with the condition in infants. Unfortunately, no opportunity has presented itself for employing this method on younger children. The youngest child on whom I have seen ileocolostomy performed was 2 years, and the operation caused no anxiety whatever, the child making a perfect recovery.

The advances recently made in the treatment of congenital pyloric stenosis have shown that gastro-enterostomy can be borne by exceedingly feeble infants. It is reasonable to expect that an ileocolostomy could be performed with even

POST-MORTEM RECORDS OF 19 CASES OF CONGENITAL ENLARGEMENT OF THE COLON AND RECTUM AT THE HOSPITAL FOR SICK CHILDREN, GREAT ORMOND STREET.

Case	Sex	Age at Onset of Symptoms	Age at Death	Treatment	Condition of Colon	Condition of Sigmoid	Condition of Rectum
1. L. G. 1868	M	Birth	4½ years	Medical	"Contracted"	Dilated and hypertrophied	Not stated
2. H. J. D. 1891	M	Birth	3 months	Medical	Hypertrophied and dilated	Hypertrophied and dilated, ulcerated	Thickened and narrowed 2″ above anus, circular thickening 1/8″ in. extent.
3. F. S. 1894	M	Birth	3 years	Medical	Distended	Distended	Distended to 3″ from anus
4. T. S. 1895	M	Birth	5 months	Medical	Hypertrophied and distended	Hypertrophied and distended kink at pelvic brim	Normal
5. C. F. C. 1895	F	Birth	4 months	Medical	Dilated and slightly hypertrophied	Elongation of mesentery	Not stated
6. C. F. G. 1897	M	6 m'ths	3 years 9 months	Medical. Colostomy	Distended and slightly hypertrophied	Distended, hypertrophied, ulcerated	Distended and hypertrophied to anus
7. H. F. 1899	M	Birth	4 years 9 months	Medical	Dilated and hypertrophied, ulcerated	Ditto	Much hypertrophied down to anus
8. S. H. 1899	M	Birth	4 months	Medical	Dilated and hypertrophied	Dilated and hypertrophied. Thickness increased progressively towards rectum	
9. H, L. 1904	M	Birth	3 weeks	Medical	Dilated and hypertrophied	Dilated and hypertrophied	Not stated
10. A. R. 1905	M	Birth	10 weeks	Medical	Slightly dilated	Dilated, thickened, ulcerated	Dilated and thickened

POST-MORTEM RECORDS—*continued.*

Case	Sex	Age at Onset of Symptoms	Age at Death	Treatment	Condition of Colon	Condition of Sigmoid	Condition of Rectum
11. C. B. 1905	M	Not known	10 months	Died on admission	Dilated	Dilated	"Ballooned"
12. A. S. 1905	F	Birth	1 year 3 months	Ileum anastomosed to rectum	Hypertrophied	Hypertrophied	2″ from anus circular band ¼ in. thick
13. J. S. 1908	M	Birth	2 months	Medical	Hypertrophied	Hypertrophied	Last part of rectum quite thickened
14. V. R. 1908	F	Aged 2 m'ths	4 months	Died on admission	Enlarged	Much enlarged	Hard and thickened in lower part. Hypertrophy of circular coat.
15. F. C. 1908	M	Birth	11 months	Colostomy, Ileosigmoidostomy	Dilated and thickened	Dilated and thickened	Dilated and thickened to 4 in. from anus.
16. I. R. 1909	M	Birth	2 years 7 months	Resection of 1 ft. of sigmoid	Distended, thickened	No note	
17. D. S. 1910	M	Birth	3 years 8 months	Appendicostomy	Dilated and hypertrophied		Normal
18. E. H. 1911	M	3½ years	4 years	Medical	Distended	Greatly distended and some hypertrophy	Greatly hypertrophied
19. R. L. 1912	M	Birth	12 years	Resection of colon	Dilated and hypertrophied		Very dilated and hypertrophied to anus.

greater safety, as patients with congenital colon disease do not as a rule present serious symptoms until rather later in life, and they are never so feeble as the infant with pyloric stenosis, provided that medical treatment has not been persisted in too long. I believe that an ileocolostomy would give temporary relief and tide the patient over for one or two years until the radical operation could be performed.

The table on pp. 358, 359, shows the chief findings at the post-mortem examination of nineteen cases, and a short account of the cases treated by Sir Arbuthnot Lane by anastomosis and resection.

I am much indebted to the Medical Committee of the Hospital for Sick Children, Great Ormond Street, London, for permission to publish these cases.

REFERENCES.

HIRSCHSPRUNG, *Jahrb. f. Kinderheilk.* 1888.
JAYLE, *Presse Méd.*, Paris, 1909, xvii, 813.
FINNEY, *Surg. Gyn. Obstet.* 1908, vi. 6.
TREVES, *Lancet*, 1898, i, 276.
WILKIE, *Edin. Med. Jour.*, 1909, ii, and Oct., 1910.
FENWICK, *Brit. Med. Jour.*, 1900, ii, 564.
BARLING, *Lancet*, 1913, i, 231.
DUVAL, *Rev. de Chir.*, Paris, 1909, xl, 506.
LOWENSTEIN, *Centralb. f. Allg. Path.*, 1907, xviii, 929.
TERRY, *Jour. Amer. Med. Assoc.*, Chicago, 1911, lvii, 731.
CHEADLE, *Lancet*, 1898, i, 399.
FLETCHER AND ROBINSON, *Brit. Med. Jour.*, 1907, i, 370

HYPERTROPHIC FIBROSIS OF THE GUT CAUSING CHRONIC OBSTRUCTION; A SEQUEL TO A STRANGULATED HERNIA.

By C. A. MOORE, Bristol.

Considering how common a condition strangulated hernia is, it is somewhat surprising that complications due to the injured bowel so rarely occur, and I have, therefore, thought the following well-marked case worthy of record.

The patient, H. J., male, aged 21, was seen on September 28, 1911. He stated that a small swelling had appeared in the right groin some nine months previously. It had only been present for twenty-four hours, and had never reappeared, but he had always worn a truss since.

At 10 a.m. on the day of admission, patient was carrying a bag of cocoa-butter, weighing 2 cwt., along a plank, from which he slipped and missed his footing. A large swelling immediately appeared in the right groin, and severe pain in the abdomen followed. He made several unsuccessful attempts to reduce the swelling, and came to the Hospital twelve hours after the onset, having suffered severe pain in the interval, and vomited several times.

On examination, a swelling the size of a large fist was discovered in the right inguinal region, with all the signs of a strangulated hernia. No attempt at reduction by taxis was made, and immediate operation was undertaken.

The swelling was cut down upon and the sac opened. It contained a small quantity of blood-stained fluid, and some eighteen inches of small intestine, dark purple—almost black—in colour. No sign of gangrene at the site of constriction was present, the bowel retained its normal elasticity, and the peritoneal coat its shining appearance. The mesentery was considerably infiltrated with blood, but pulsation in the vessels was quite obvious. The colour of the strangulated bowel considerably improved while under observation, and it was decided that it could safely be returned into the abdomen.

This was done, and a radical cure carried out according to Bassini's method. Next morning, the patient was much better, and no more vomiting had occurred.

Twenty-four hours after operation, severe abdominal pain set in, accompanied by vomiting. The temperature rose to 100°, and the pulse to 130. The abdomen was markedly distended, but not particularly tender or rigid.

The question arose as to whether, after all, the injured bowel had not given way and set up perforative peritonitis. However, although the patient's condition was serious, I was inclined to think that the condition was one of dynamic intestinal obstruction, due to paresis of the injured bowel.

An enema produced a fair result, so the patient was put on four-hourly turpentine enemata, simultaneously with an intramuscular injection of 1 c.c. of pituitary extract, in the hope of inducing contraction of the distended and paralyzed intestine.

The result was most satisfactory: contraction of the bowel was induced,

and the bowels were moved several times. The distention subsided, the condition of the patient rapidly improved, and within forty-eight hours he was well on the road to recovery. No further complications occurred, the wound healed by first intention, and the patient was discharged a fortnight later, quite well.

On October 22, a week after discharge, the patient was sent back from the Convalescent Home with a diagnosis of "intestinal obstruction." However,

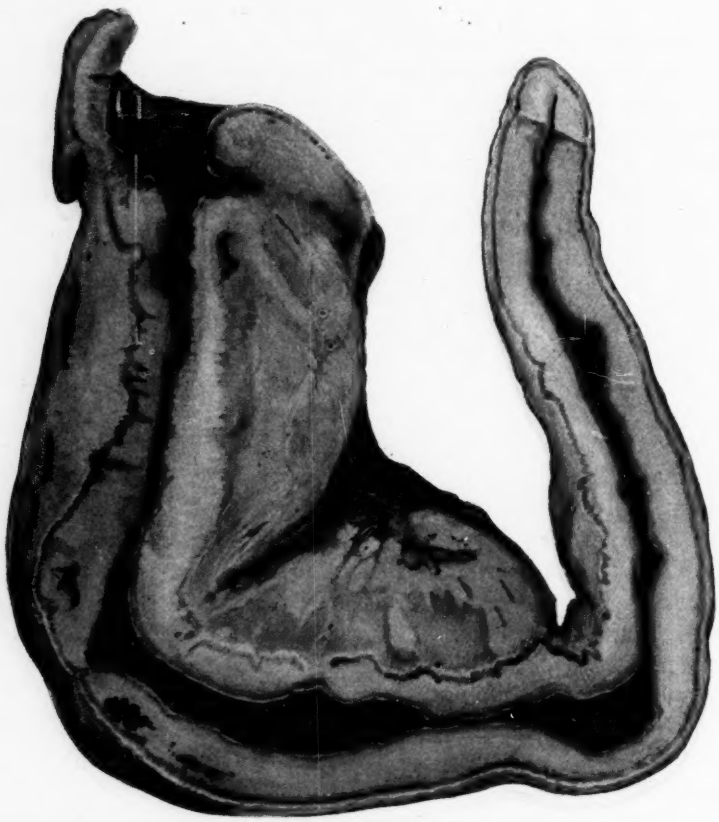


FIG. 215.—Coloured drawing of the piece of small intestine cut longitudinally after hardening. The concavity is occupied by the remains of the mesentery and a large mass of fibro-fatty tissue. An irregular dark band represents the muscle layer, and from the position of this it will be seen that for the most part the fibrosis is submucous. In this submucous fibrous tissue are seen several hæmorrhagic areas. The left-hand limb of the loop is the proximal portion of intestine, and here the transition between healthy and diseased bowel is abrupt. The distal limb of the loop shades off gradually into normal gut.

his symptoms seemed to be due only to a slight digestive upset, with constipation and a little vomiting, and subsided in three days with simple remedies.

During the next few months the patient complained of several marked attacks of the same kind. Each one commenced with a dull aching pain across the lower abdomen, which suddenly became worse, and a swelling appeared in the right lower abdomen. This presently subsided, with much rumbling. He took aperients, which caused diarrhœa and increased the pain. Vomiting occurred

only once or twice. The appetite was good, but the patient ate sparingly, since his experience was that the taking of food was liable to precipitate an attack.

It seemed clear that the patient was suffering from a condition of mild recurring attacks of intestinal obstruction, so he was readmitted on March 15, 1912.

Examination revealed nothing, as a rule, which could throw any further light on the condition, but on one or two occasions a swelling could be made out as described by the patient in the lower abdomen, sometimes on one side, sometimes on the other. There was decided abdominal distention, with occasional visible peristalsis. The scar of the operation was quite sound, and nothing abnormal was revealed by a rectal examination. The patient was advised to submit to exploration, and an incision was made below the umbilicus and just to the right of the middle line.

A swelling was immediately discovered in the ileum, ovoid in shape, about five inches long, and involving the bowel itself as well as its mesentery. The gut was collapsed below, but markedly hypertrophied above. No enlarged glands or other abnormality were discovered, and no trace of a sac was present in the right inguinal region. The involved portion of bowel was clamped and cut away, the ends were closed, and lateral anastomosis by simple suturing performed. The patient recovered without an unfavourable symptom, and has since remained quite free from any further attacks of pain.

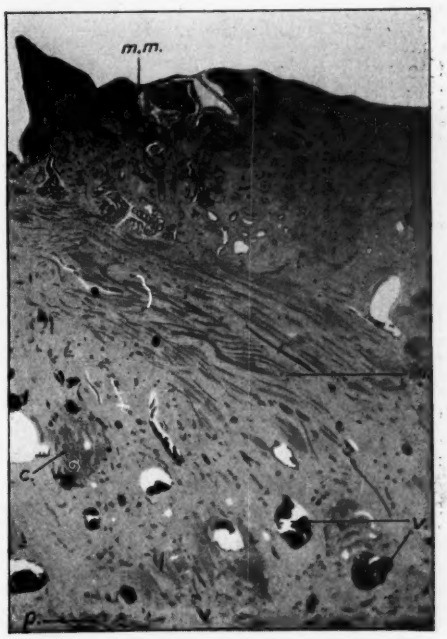


FIG. 216.—MICROSCOPICAL SECTION OF THE WALL OF THE FIBROSED GUT SEEN UNDER A LOW POWER.

m.m. = Mucous membrane; *m* = Muscle layer; *v* = Dilated and thrombosed vessels; *c* = Perivascular cellular infiltration; *p* = Subperitoneal cells. The remainder of the section is occupied by young fibrous tissue.

The appearance of the portion of bowel resected is well shown in the sketch (*Fig.* 215). The tumour consists of a smooth ovoid swelling, some five inches in length and somewhat sharply demarcated from the bowel above and below. The lumen is reduced to about the diameter of a goose-quill, and the maximum thickness of the wall is nearly an inch and a half. The thickening extends to all the coats, but is especially well marked in the submucous layer. The region of the mesentery shows the presence of a considerable quantity of fat.

The intestine above the obstruction shows marked dilatation, while it is collapsed below; but the wall both above and below shows thickening similar to that in the main swelling, but in a much less degree.

Microscopic sections (*Fig.* 216), taken from the swelling in various places, show that the thickening is due to the formation of young fibrous tissue from the organization of blood-clot and inflammatory effusion. The mucous membrane

shows well-marked round-celled infiltration, and there is considerable perivascular effusion.

Nowhere is seen any trace of a deeper layer of mucous membrane, which would point to the swelling being due to the presence of an intussusception.

It is especially noteworthy, that the mucous membrane is quite intact throughout the whole lumen of the affected part of the gut, so that it cannot be regarded as the cicatricial contraction of an ulcer.

GENERAL OBSERVATIONS.

The operation for strangulated hernia is a very successful one and, provided the patient is seen early and before gangrene of the injured bowel threatens, it is followed by very few unpleasant sequelæ. In most cases the injured bowel rapidly resumes its normal functions, and convalescence is speedy and uninterrupted.

The present case serves as a reminder that the well-known and fatal complication of more or less massive gangrene of the injured bowel is not the only danger to which the patient may be exposed.

The consideration of the question of gangrene is outside the scope of the present article, but it has long been recognized that narrowing of the injured bowel may occur from stricture, and may give rise to intestinal obstruction. Inasmuch, however, as the obstruction is usually in the small intestine, the contents of which are fluid, it is probable that minor degrees of narrowing often pass unrecognized.

The usual condition present is one of ring-stricture of the bowel at the actual strangulating point. When the bowel is damaged by such a sharp edge as, for instance, a tense Gimbernat's ligament, there may be serious injury from pressure over a very limited area. In such cases, it is a well-known fact that sloughing usually starts from inside the bowel, and the mucous coat is the first to suffer. In more advanced cases, the peritoneum remains as the sole defence between the patient and perforative peritonitis.

When the bowel wall has been so seriously damaged as this, the process of repair involves the formation of scar-tissue, which may proceed to the extent of considerably narrowing the lumen of the bowel at the point involved.

The case recorded above is probably an extreme instance of what may often happen in a minor degree. In this case, eighteen inches of bowel were strangulated, and some six inches so seriously as narrowly to escape gangrene; and the organization of the consequent inflammatory effusion and blood-clot caused the fibrous thickening of the bowel wall, extending for a distance of some inches in the length of the gut, instead of a mere ring.

A somewhat similar case was recorded by Newton Pitt.[1] A femoral hernia, down for a week with intense pain, was then reduced by taxis. Vomiting commenced five days after the reduction, and was repeated at frequent intervals during the next three months, with tympanites and griping abdominal pain. Death ensued, which a post-mortem revealed to be due to perforation of the gut. The report says that " the mesentery was thickened and fibroid, and the muscular coat hypertrophied, extending for an inch and a quarter."

Bryant[2] had a patient, just about to leave hospital after an operation for strangulated femoral hernia, when irregular attacks of alternating diarrhœa and

constipation set in. Vomiting commenced seven weeks after the operation, and death occurred a month later. Autopsy showed that one and a half inches of small intestine were contracted, and the coats thickened.

An interesting case is reported by Obre.[3] On May 3, 1850, he operated on a case of right inguinal hernia, strangulated three days, and found the intestine "intensely purple." The following December, flatulence and pain after food began, with distention of the abdomen and occasional vomiting. The following February there was an acute attack, with three days' fæcal vomiting, but the patient recovered, after an action of the bowels, when apparently actually moribund. The patient had another attack on March 10, and died on April 29.

At the post-mortem, "a contraction was found . . . formed by the portion which had formerly been relieved by the operation; this part had taken on an inflammatory action, and deposited fibrin between its coats, so as to only allow water to drip through the contracted tube." Death was due to perforation above the obstruction.

Fagge had a patient who died from continuous vomiting two months after an operation for strangulated hernia. He found that one and a half inches of intestine were narrowed, and the coats thickened by hard white cicatricial tissue, while the mucous membrane was almost devoid of villi.

Other references to cases of a like nature are :—[4], [5], [6], [7].

In the case described above, the process was possibly somewhat less acute, although, had the patient been left a fatal result would certainly have followed, sooner or later.

The thickening in the bowel is perhaps comparable to that seen in cases of hyperplastic tuberculosis of the cæcum, where also the main thickening is seen in the submucous layer, and where the bowel is sometimes included in a fibro-adipose deposit nearly two inches thick, which seems to be associated with the chronic inflammation and obstruction.[8] A somewhat similar thickening in the stomach has been described in cases of ulcer by Thomson and Graham[9] under the title of fibromatosis of the stomach, while Dalziel[10] recorded cases of general and localized thickening of the intestinal coats ascribed by him to chronic interstitial enteritis. One of the specimens shown by him at the Brighton Annual Meeting bore a close resemblance to the specimen removed from my case.

It is interesting to note that a fibro-fatty deposit round a mucous canal, chronically obstructed, has been noted in cases of stone impacted in the duct of a salivary gland (Owen, Berger), and also round the site of impaction of a calculus in the ureter (Norman Moore).

REFERENCES.

[1] *Pathological Society's Transactions*, 1891, 119.
[2] *Med. Times and Gaz.*, 1872, 363.
[3] *Pathological Society's Transactions*, iii, 95.
[4] *Brit. Med. Jour.*, 1897, ii, 951.
[5] *Bull. et Mém. de la Soc. de Chir. de Paris*, 1880, 706.
[6] GARRÉ, *Beit. z. klin. Chir.* 1892, 187.
[7] MOAS, *Deut. med. Woch.*, 1895, 365.
[8] HARTMANN, *Brit. Med. Jour.*, 1907, i, 849.
[9] *Edin. Med. Jour.*, 1913, July.
[10] *Brit. Med. Jour.*, 1913, ii, 1068.

CONGENITAL RADIO-ULNAR SYNOSTOSIS.

By D. P. D. WILKIE, Edinburgh.

Congenital synostosis of the bones of the forearm is a malformation which has attracted little attention in this country. Although there are now over forty cases recorded in medical literature, it must still be regarded as one of the rarer deformities of the forearm bones, congenital absence of the radius and congenital dislocation of the head of the radius without synostosis being more frequently met with.

The absence of all mention of this deformity in most text-books of surgery must, however, have led to many cases being passed unrecognized. Thus it is significant that since my attention was drawn to it less than a year ago, I have met with three cases. The first record of the condition is that by Sandifort[1] (1793), and in his "Museum Anatomicus" a typical specimen is figured. R. W. Smith[2] (1852) described a similar specimen, and in Malgaigne's[3] (1856) work on "Fractures and Dislocations" there is a drawing of an undoubted case. Allen[4] (1880) also described a dissected specimen showing this condition. It was not till 1893, however, that the first accurate clinical record of a case was made by Schmid,[5] and following closely on this, cases were described by Reise[6] (1893) and Kümmel[7] (1895). With the introduction of the *x*-rays as a means of medical diagnosis, this deformity became more frequently recognized, and since 1900, cases have been reported from all quarters.

This deformity, which may affect one or both forearms, is met with almost equally in both sexes. In some cases, and more especially in those where the synostosis is associated with a dislocation of the head of the radius, a strong hereditary element is present. Thus in Abbott's[8] cases the deformity was met with seven times in five generations of one family; in the case of a young boy recorded by Blumenthal,[9] a young sister, the father, and the paternal grandmother were similarly affected; and in one of von Sury's[10] cases the patient's sister, mother, and maternal grandmother suffered from the same malformation.

Clinical Features.—The cardinal feature of the deformity is the fixity of one or both forearms in a position of pronation, a condition which has been present since birth. Movements at the elbow-joint are usually free, although, as Drenkhahn[11] first noted, extension is often not quite maximal. Movements at the wrist joint are often excessively free, due to a laxity of the capsular ligaments; there is no movement, however, of the radius on the ulna, and between these bones there appears to be firm osseous union.

When the deformity is unilateral, the affected forearm appears thinner and is sometimes shorter than the sound one. It has a curious twisted appearance, due to an alteration in the axis of the principal groups of muscles, and on the postero-lateral aspect in its upper part there is a well-marked sulcus corresponding to the normal position of the head of the radius.

On palpation, it is found that the shaft of the radius is very stout and well formed, whilst the head of the radius cannot be felt in its usual position, but is either displaced backwards or forwards, or imperfectly developed and felt as a prominence on the ulna. The patient is quite unable to turn the palm of the hand upwards, and must always pick things up with the hand in a position of pronation. Apart from this, the subjects of this deformity complain of little, never having known the free use of the forearms.

Morbid Anatomy.—Two types of this condition may be distinguished: (1) *Primary or true radio-ulnar synostosis*, in which the upper end of the radius is imperfectly formed and fused to the ulna for a distance of several centimetres; (2) *Radio-ulnar synostosis complicating congenital dislocation of the head of the radius*: in this type the head of the radius is more or less normally developed, but is dislocated, and the two bones of the forearm are fused just below their upper ends.

Among later writers on this subject, Ahreiner[12] and Dietz[13] have recognized the importance of distinguishing between these these two types, which differ somewhat from those previously described by Rais.[14]

1. *Primary Radio-ulnar Synostosis.*—In this class of case, the upper end of the radius has none of its normal specialized contour, but is completely fused to the ulna for a distance of from 3 to 6 cm. The bony union is of an intimate nature, there being no intervening compact layer between the spongiosa of radius and ulna, and this "cancellated bone fusion," as Blodgett[15] describes it, is of importance in its bearing on the etiology of the deformity. The line of fusion extends obliquely downwards on the front of the ulna, and its lower end has usually an arcuate form corresponding to the upper limit of the interosseous membrane; hence the term "ossification arciforme" applied to it by Longuet and Péraire.[16] The position of pronation in which the bones are fused, and which, as will be shown later, can be accounted for on developmental grounds, readily explains the disability from which the patient suffers.

The shaft of the radius arches forwards more than is normal, and it is relatively longer and stouter than that of the ulna, which is more slender than usual, conveying the impression, first, that there has been either some arrest in the growth of the ulna, or stimulus to the growth of the radius, and next, that the radius has to bear most of the strain on the forearm. In one case, recorded by Roskoschny,[17] this arrangement was reversed, the radius being very slender and relatively short, and the ulna very stout and long.

The lower ends of the radius and ulna are almost invariably free; in one instance only (Appraillé)[18] has synostosis of the distal ends been observed. Occasionally there may be, as in Melchior's[19] case, a backward displacement of the lower end of the ulna, i.e., Madelung's deformity. In one of my cases the lower ends of both ulnæ showed a very noticeable and symmetrical thickening, suggesting that there was some tendency to a fusion of the lower as well as of the upper ends of the bones. The external condyle of the humerus may be enlarged, as in the cases of Smith and Allen, and in one of my own. As a consequence of the bony union, the soft parts show a considerable deviation from the normal. The supinator muscles are defective, and the supinator brevis may be altogether absent, as in the case operated on by Dawson.[20] The pronator radii

teres and pronator quadratus are much shortened, and the axis of the flexor and extensor muscles is altered. The fascial tissues show changes corresponding with those of the muscles, and the interosseous membrane is usually narrower than normal in its upper part. These facts must be borne in mind when considering the advisability of operative interference for the correction of the deformity. Primary radio-ulnar synostosis is usually a symmetrical deformity ; in over 80 per cent of the recorded cases which conform to this type, both forearms have been affected. The hereditary element is perhaps not so pronounced as in cases associated with dislocation of the head of the radius, nevertheless in Dawson's and in Roskoschny's cases it was well marked.

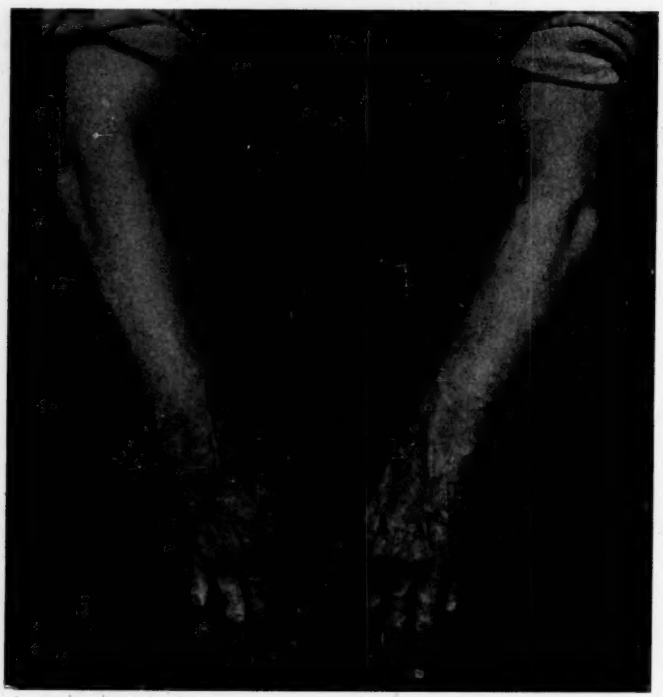


FIG. 217.—*Case* 1. To show characteristic contour of forearms in position of pronation. Note well-marked sulcus on postero-external aspect of elbow.

2. *Synostosis with Dislocation of the Head of the Radius.*—In this type of deformity the head of the radius is more or less well developed, but is dislocated, and the upper part of the shaft of the bone is fused to the ulna in the region of the coronoid process. Of fifty-one cases of congenital dislocation of the head of the radius collected by Blodgett (1906), seventeen showed radio-ulnar synostosis. The dislocation may be either backwards or forwards, more frequently the former (Kienböck[21]). As the fusion invariably occurs with the bones in a position of pronation, it will be obvious that the point of union with the ulna will be at, or close to, the head of the bone in cases of forward dislocation, and somewhat lower down on the shaft of the bone in backward dislocations. The bony fusion appears to be neither so extensive nor so intimate as in primary synostosis, but

the radius is as a rule relatively longer and stouter than the ulna, and shows the same curvature as in the primary type.

This type of deformity is more frequently unilateral, and is not uncommonly associated with other deformities, e.g., supernumerary thumb (Schmid), absence

FIG. 218.—*Case* 1. Maximum supination with shoulder rotated outwards. Note sulcus below and in front of olecranon.

of both thumbs (Joachimsthal[22]), or syndactilism (Reise), Hlawecek[23] points out that when an associated deformity of the hand is present, it is almost invariably on the radial side, conforming to Gegenbauer's theory of the "Radialstrahl."

The following three cases I have personally studied. For permission to use *Case* 2, I am indebted to Dr. Harry Rainy, under whose care the patient was while in hospital.

Case 1.—J. H., male, aged 34. Labourer. Came to hospital complaining of a strain of his left shoulder sustained while lifting a weight. It was seen that both forearms were fixed in a position of pronation. Patient stated that this condition had always been present, and that, although it handicapped him greatly at his work, he was nevertheless able to earn a livelihood as a labourer.

Patient could flex his elbow-joints freely, and extension was practically, if not quite, of full range. Supination was entirely absent, and when movement at the shoulder-joints was prevented, the palms of the hands could not even be brought to face each other. The contour of the forearms was quite distinctive. When held in what for him was the natural position, namely, full pronation, the olecranon was seen to stand out prominently; and between it

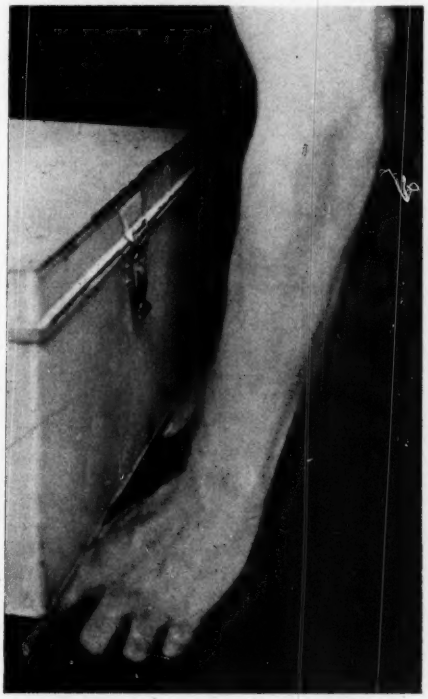


FIG. 219.—*Case* 1. Patient attempting to lift a box, showing the maximum degree of supination possible.

and the prominence of the muscles arising from the external condyle of the humerus, was a sulcus corresponding to the position of the anconeus and supinator brevis muscles (*Fig.* 217). When the forearm was viewed from the flexor aspect (the shoulder being rotated outwards), it presented a curious twisted appearance, there being a marked sulcus just below and in front of the olecranon (*Fig.* 218). On being asked to lift a box, he attempted it in the position shown in *Fig* 219. Radiograms of the elbows and forearms showed that on both sides the radius was imperfectly developed at its upper end, and was fused to the ulna in the uppermost 2 inches of its extent. The fusion was a complete one, there being no intervening compact bone, but a spongiosa common to both. It was further noted that the shaft of the radius was unusually stout and curved, whilst that of the ulna was unduly slender (*Figs.* 220 and 221). The distal radio-ulnar articulation appeared normal.

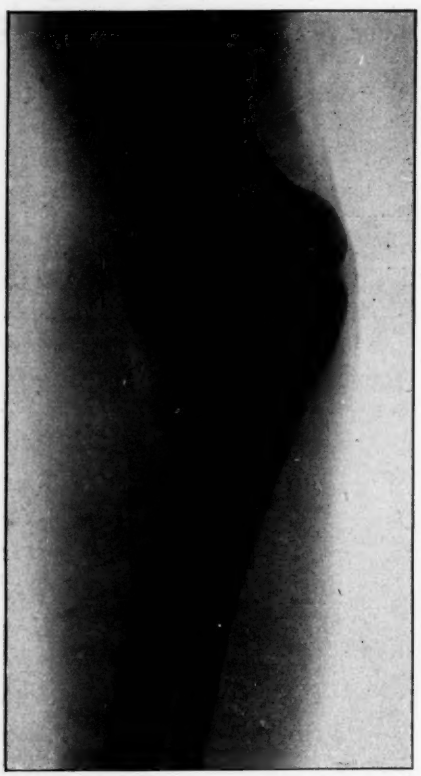


FIG. 220.—Radiogram of left elbow in *Case* 1. Note complete "cancellate bone fusion," stout radius, and slender ulna.

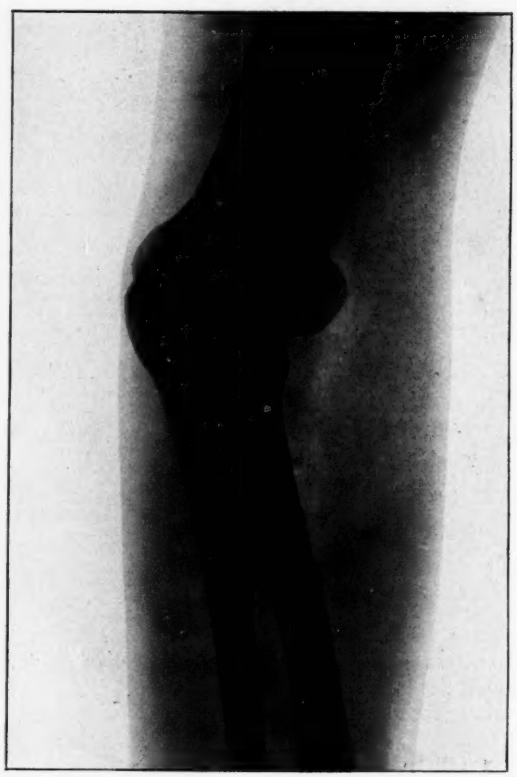


FIG. 221.—Right elbow, *Case* 1.

Case 2.—Female, age 24. Laundry worker. When a small child it was noticed that she had not the power of supination. She was taken to a medical man, who advised an operation; to this her parents would not consent. For some years she had been employed in a laundry doing ironing, which she managed without difficulty. She noticed the disability most when receiving change in a shop, as she could not take it into the palm of her hand, but required always to pick it up with the hand pronated. She came to hospital on account of rheumatism in the right elbow and wrist. There was no history of any similar deformity in the family for at least two generations back. On examining the upper limbs, the hands were seen to be kept

constantly in a position of full pronation, and the forearm had the characteristic shape seen in the previous case, there being a deep sulcus visible on the postero-lateral aspect of the upper part of both forearms.

Flexion at the elbow-joints was quite free; extension was not quite maximal. When asked to supinate the hands, the whole upper limb was rotated outwards, and a slight degree of supination was carried out in the wrist-joint, the ligaments of which appeared to be unusually lax. The bones of the forearm took no part in the movement, and the palms of the hands could not even be made to face each other (*Fig.* 222). On palpation, the head of the radius could not be felt in its normal position on either side, and the bones of the forearm were united and could not be moved the one on the other. *X*-rays of the forearms showed that on both sides the upper end of the radius was imperfectly formed and was fused to the ulna for a distance of 5 cm. Over this portion there was complete fusion of the bones, there being a spongiosa common to both. The lower end of the bony bridge showed the typical arcuate form. The shaft of the radius was seen to be abnormally stout and curved, that of the ulna unusually slender (*Fig.* 223). About 4 cm. from its lower end, the ulna became suddenly thicker

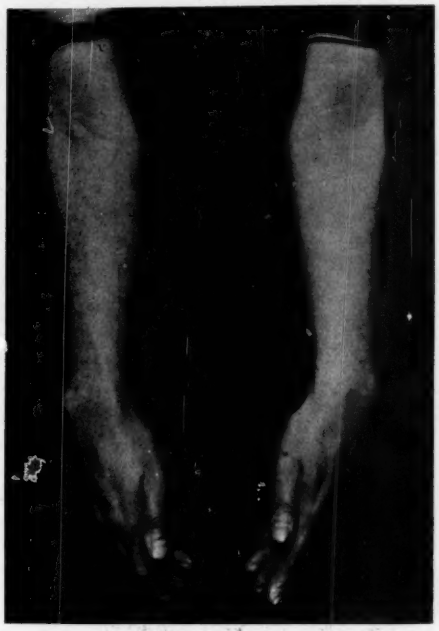


FIG. 222.—*Case* 2. Forearms in position of maximum supination.

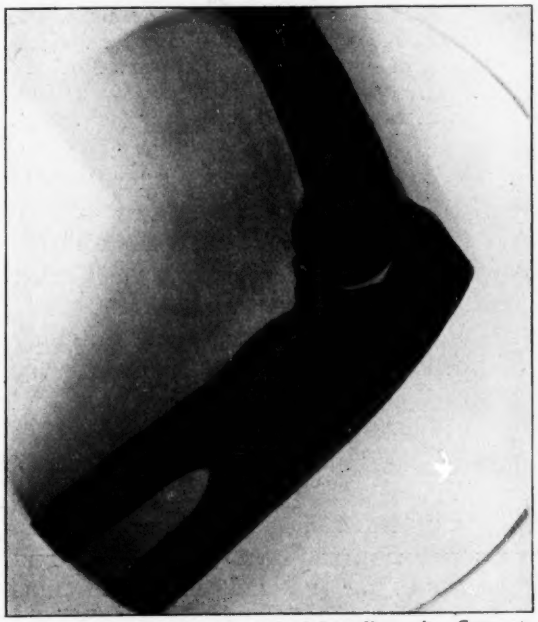


FIG. 223.—Radiogram of right elbow in *Case* 2. The intimate character of the bony fusion is well seen. Note the characteristic arcuate form of the lower end of the area of fusion. The left elbow gave an identical picture.

FIG. 224.—Lower ends of radius and ulna in *Case* 2, showing thickening of the mesial aspects of both bones at their lower ends. The bones of the left forearm showed identical outlines.

on its radial side, which increase in diameter was continued to its lower extremity. At a corresponding point in the radius there was also a slight thickening (*Fig.* 224). These bony abnormalities were identical on the two sides.

Case 3.—Boy, age 5½ years, the second child in a family of four. No history of any deformity in the family. Two months before the child was brought to hospital, his mother had noticed that he grasped things in a peculiar way with his left hand, and that he could not turn the palm of this hand upwards as he could that of the right. She knew of no accident which could account for this, and the child had never complained of the arm. On examination, the child was found to be well nourished and well developed, the arms were of equal length, but the left forearm was thinner than the right, and the left hand was constantly kept in a position of pronation. Flexion and extension at the elbow were not interfered with; indeed, a considerable degree of hyper-extension of the left elbow could be carried out. When asked to supinate his left hand, he rotated the whole upper limb outwards at the shoulder, but could not make the palm of the left hand even face its fellow. On palpating the arm, a marked sulcus could be felt over the normal position of the head of the radius, which was found dislocated forwards, and firmly fixed to the ulna. A radiogram of the left elbow showed that the upper end of the radius was enlarged, and displaced forward against the front of the ulna. Just below the upper extremity of the radius there was a rounded prominence lying opposite what appeared to be a corresponding excavation in the ulna, the appearances closely resembling those in Kienböck's case of exostosis of the upper end of the radius. The radius was not bent or unduly stout, as in the two previous cases (*Fig.* 225).

FIG. 225.—Radiogram of left elbow in *Case* 3.

Etiology.—Whilst some writers have doubted the congenital nature of the deformity, the evidence in favour of this is overwhelming. When we consider the hereditary nature of the deformity, so well marked in Dawson's case, its localized and symmetrical character, and its occurrence along with other unquestionable and congenital malformations, there is no room for doubt.

A study of the development of the bones of the forearm affords a ready explanation, not only of why a congenital fusion of the radius and ulna may be found, but also of why it should occur at the proximal ends of the bones, and in a position of pronation.

In their studies of the development of the limbs, Bardeen and Lewis [24] found that in an embryo of four and a half weeks, the radius and ulna were distinct below, but fused above (*Fig.* 226). Further, in a fœtus of six weeks. Lewis [25] found that whilst the distal ends of the forearm bones were distinct and separated from each other, the perichondrium of the proximal end of the radius was continuous with that of the adjoining surface of the ulna (*Fig.* 227). It would appear, therefore, that some factor operating at this early period must be responsible for the local arrest in development. In the earlier months of intra-uterine life the forearm occupies a position midway between pronation and

supination, and according to Blumenthal, in order to *x*-ray the bones of the forearm of a fœtus in a position of supination one must rotate the upper arm until the external condyle of the humerus is lying on the plate, and the transverse axis of the humerus is vertical. The position of pronation found in this deformity is therefore the normal for the young embryo. The bending and relative increase in length of the radius is explained by Blumenthal by the law of Lambertz, namely, that in the bones of the extremities, the ends which show a more elaborate development as regards shape have a less degree of growth; therefore, when for some reason the radius does not develop in form, it has a tendency to increase in length. In the case of the primary congenital synostosis it is very improbable that uterine pressure, amniotic adhesions, or other mechanical

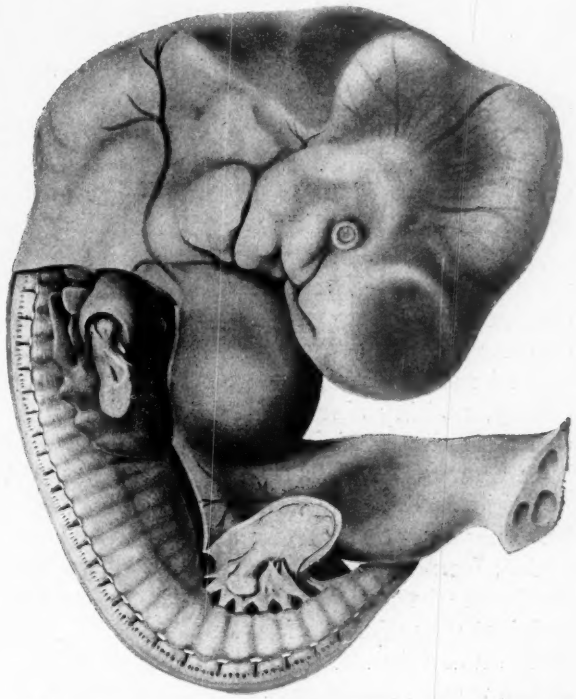


FIG. 226.—Bones of forearm in a four-and-a-half-weeks embryo. (*After Bardeen and Lewis.*)

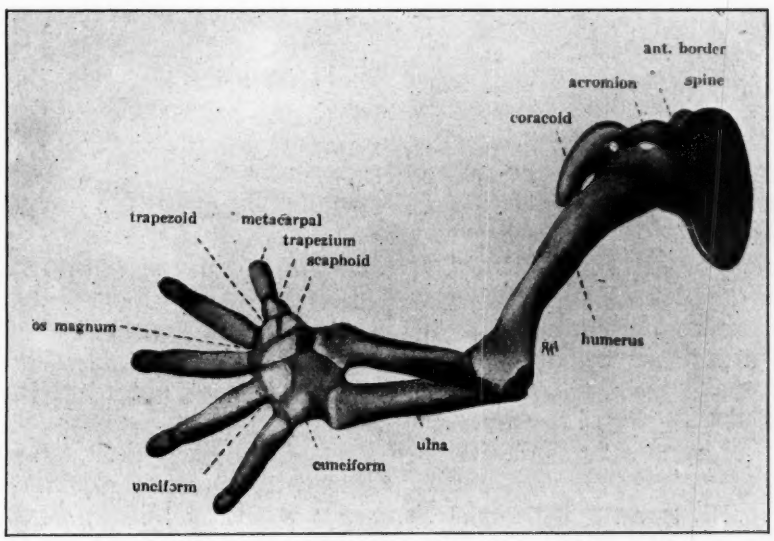


FIG. 227. Skeleton of upper limbs of a six weeks embryo. Note position of proximal end of radius in front of ulna. (*After Lewis.*)

factor plays any part in the etiology. As Lieblein[26] has pointed out, it belongs to a group of deformities of the osseous system characterized by disturbances in osteogenesis in isolated and frequently symmetrical sites in the body, and that the defect, whatever it be, is transmitted in the germ-plasm. Hamilton[27] has suggested that this deformity represents a partial return to one of the lower vertebrate types of fore-limb, a fusion of these bones being found normally in bats, some ungulates, and in camels.

In regard to the synostosis associated with congenital dislocation of the head of the radius, the causative factor must operate at a later period in fœtal life than in the case of the true synostosis. In some cases, indeed, it is quite possible that the synostosis takes place after birth, when, consequent to increased movement, the periosteum of the two bones where they lie in contact is irritated and possibly lacerated, and new bone is laid down. Melchior is strongly of this opinion, and in support of it quotes the case of Schilling,[28] in which a girl of eleven years suffering from symmetrical synostosis was said to have had normal movement of the arms during the first few years of life. In my own *Case* 3, nothing abnormal had been noted until the child was five years old, and the radiographic appearances suggested strongly that there had at one time been a movable joint between the radius and ulna.

Stimson[29] is doubtful whether this condition is congenital at all; but one has only to review the family histories in the cases recorded by Abbott, Pye-Smith, Joachimsthal, and others, to be convinced that congenital dislocation of the head of the radius is a well-established clinical entity. It is possible that deficient space for the fœtus in utero may have something to do with this type of the deformity. As Blumenthal points out, a movement of external rotation of the upper limbs occurs during the later months of intra-uterine life, and this movement exposes the external condyle of the humerus and head of the radius to any abnormal pressure which may be present.

Treatment.—In the cases of primary synostosis, it is questionable whether surgical intervention should ever be undertaken. When one reflects that the bony bridge constitutes but a part in the deformity, and that the soft tissues are not normally developed, the futility of a simple division of the synostosis is at once realized. In the type associated with dislocation of the head of the radius, where the soft parts approach more closely to the normal, the prospect of helpful surgical intervention is more hopeful; but even here too much must not be promised. It must also be remembered that, as Lieblein has pointed out, the handicap which this deformity entails is less to the patient, in that he has never known the advantages of supination of the forearms, and is therefore in quite a different position from the patient who, as the result of an accident, has acquired a crippling radio-ulnar synostosis.

In none of the three cases which are here recorded, did I feel justified in recommending operative treatment.

I have found records in the literature of six cases in which operative measures were employed. The first, by Kümmel (1895), was that of a child aged six years with symmetrical synostosis, where the bony bridges were divided. The ultimate result was not known. Morestin,[30] in his case, removed the head of the radius and resected the bony bridge. Immediately after this operation

no supination was possible, but by energetic after-treatment rotation to the extent of 80° was obtained. In Schilling's case, the bony bridge was divided and a flap of extensor carpi radialis interposed between the bones. Two months later, 78° rotation was possible. Stretton[31] did not obtain great improvement in his case by division of the bridge and resection of the head of the radius; similarly, Rais was disappointed with the lack of improvement after division of the synostosis in his patient.

The extent of the surgical interference which may be necessary to obtain any pronounced or lasting improvement in supination is well seen in Dawson's case, where five operations, consisting of division of the bridge, freeing the head of the ulna, division of the interosseous membrane, excision of the head of the radius, and lastly osteotomy of the radius, were required to obtain a satisfactory result.

REFERENCES.

[1] SANDIFORT, Museum Anatomicus, 1793, Pl. 103, Figs. 1 and 2.
[2] SMITH, R. W., *Dublin Quart. Jour. Med. Sciences*, 1852, xii, 208.
[3] MALGAIGNE, *Fractures et Luxations*, 1856, T. ii, 631.
[4] ALLEN, *Glasgow Med. Jour.*, 1880, xiv, 44.
[5] SCHMID, *Zeitschr. f. Orthopäd. Chir.*, 1893, Bd. ii, S. 57.
[6] REISE, ref. Kienböck, *loc. cit. infra.*
[7] KÜMMEL, *Bibliotheca Medica Abt. E. Chir.*, iii, 19 (Kassel, 1895).
[8] ABBOTT, *Trans. Path. Soc. London*, 1892, xliii, 129.
[9] BLUMENTHAL, *Zeitschr. f. Orthopäd. Chir.*, 1904, Bd. xii, S. 181.
[10] VON SURY, *Korrespondenzbl. f. Schweitz. Aertz.* 1909, Bd. xxxix, S. 79.
[11] DRENKHAHN, *Zeitschr. f. Orthopäd. Chir.*, 1903, Bd. xi, S. 598.
[12] AHREINER, *Beitr. z. klin. Chir.*, 1901, Bd. lxv, S. 462.
[13] DIETZ, *Fortschr. a. d. Geb. d. Röntgenstr.*, 1910, Bd. xvi, S. 22.
[14] RAIS, *Revue d'Orthopédie*, 1907, viii, 431.
[15] BLODGETT, *Amer. Jour. of Orthop. Surg.*, 1906, xiii, 253.
[16] LONGUET ET PÉRAIRE, *Bull. et Mém. de la Soc. Anat. de Paris*, 1901, 147.
[17] ROSKOSCHNY, *Deutsch. Zeitschr. f. Chir.*, 1905, Bd. lxxvi, S. 568.
[18] APPRAILLÉ Thèse, de Paris, 1901, ref. *Centralbl. f. Chir.*, 1901, 1066.
[19] MELCHIOR, *Berl. klin. Woch.*, 1912, Nr. 35, S. 1659.
[20] DAWSON, *Brit. Med. Jour.*, 1912, ii, 833.
[21] KIENBÖCK, *Fortschr. a. d. Geb. d. Röntgenstr.*, 1910, Bd. xv, S. 93.
[22] JOACHIMSTHAL, *Ibid.*, 1900, Bd. ii.
[23] HLAWECEK, *Deutsch. Zeitschr. f. Chir.*, 1896, Bd. xliii.
[24] BARDEEN AND LEWIS, *Amer. Jour. of Anat.*, 1901, i, 1.
[25] LEWIS, *Ibid.*, 145.
[26] LIEBLEIN, *Zeitschr. f. Orthopäd. Chir.*, 1909, Bd. xxiv, S. 52.
[27] HAMILTON, *Brit. Med. Jour.*, 1905, ii, 1327.
[28] SCHILLING, Inaug. Dissert. Kiel, ref. Lieblein *loc. cit.*
[29] STIMSON, *Fractures and Dislocations*, 3rd Edit. 1900.
[30] MORESTIN, *Bull. et Mém. de la Soc. Anat. de Paris*, 1904, 60.
[31] STRETTON, *Brit. Med. Jour.*, 1905, ii, 1519.

A CLINICAL DEMONSTRATION OF SOME INTERESTING CASES, ILLUSTRATING THE PRINCIPLES OF GROWTH AND REPAIR IN BONE.

By RUTHERFORD MORISON, Newcastle-upon-Tyne.

Fracture in the Site of a Gumma: a Rare Case.—A heavy, strong man, aged 20, had suffered from "rheumatism" in the thigh and leg which had disturbed him at nights for three months. Whilst walking in the street, his thigh bone snapped. A skiagram showed that this was not due to sarcoma.

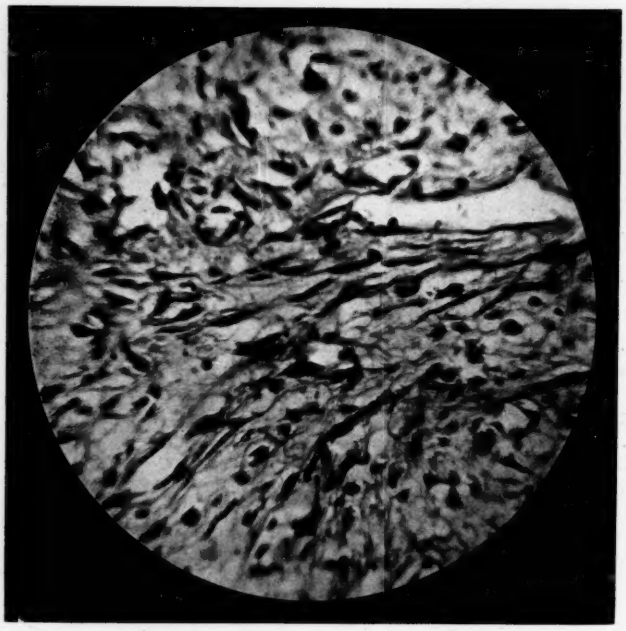


Fig 228.—Tissue removed from the femur, showing simple granulation tissue. No evidence of malignant disease.

The facies of the patient suggested congenital syphilis, and a Wassermann reaction was positive. The marked deformity of the broken bone could not be reduced by ordinary measures (*Fig.* 229A).

Operation, July 22, 1913.—Showed a rounded small granuloma in the medulla at the site of fracture (*Fig.* 228). This was scooped out and the femur plated. Mercury and iodide were given.

Healing of the wound occurred by first intention, and the femur united normally (*Figs.* 229B and 229C).

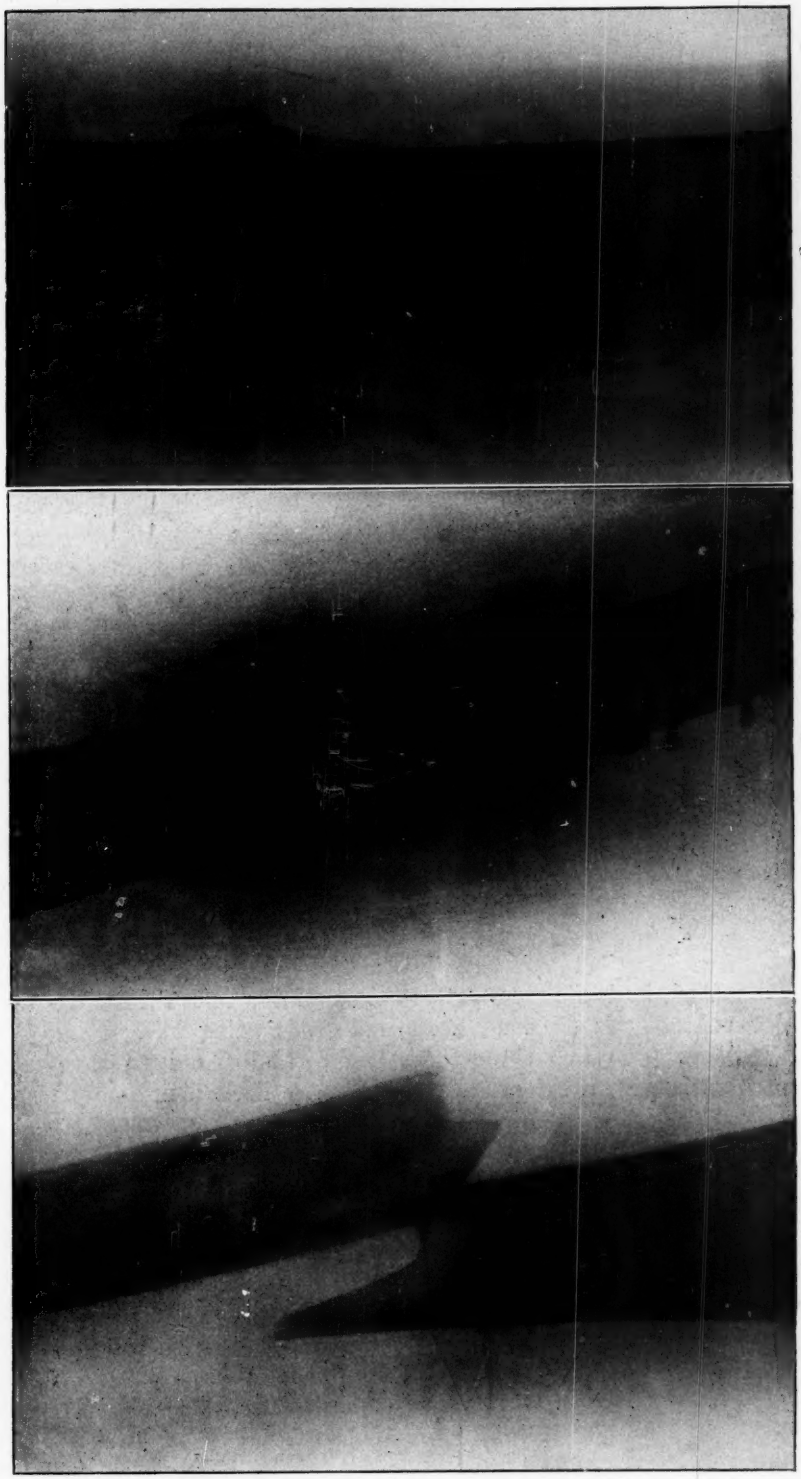


FIG. 229.—FRACTURE OF SYPHILITIC FEMUR.

A, Before operation. B, One week after operation. C, Four months after operation: plate behind left femur: the swelling is callus.

Removal of Foreign Body from the Skull. Different Behaviour of Bone Grafts according to their Size.—A boy, aged 16, was trephined for the removal of a piece of toy cannon and portions of shattered skull from his right frontal region on Jan. 12, 1894. The wound was left packed with iodoform gauze, the sutures not being tied until the next day (Jan. 13). On Jan. 16 (four days after the operation) the wound, which appeared to be free from infection, was re-opened, and a portion of the skull of a microcephalic idiot, previously drilled, was transferred to fill in the gap which had been made with the same trephine. Small chips of bone, also from the idiot's skull, were placed in the gap made by the cannon.

FIG. 230.—The upper dark area (*x*) was filled by a disc of bone, the lower light area by chips.

Examination of his head eighteen years later showed that the trephine opening appeared to be filled up by new bone; this was confirmed by skiagram (*Fig.* 230). Where the chips had been placed, however, there was a small gap without bone, and in it the cerebral pulsation could be felt. In this case, the large portion of bone had been more successful than the chips. The latter must have been slowly absorbed, for six months after operation the opening was hard all over.

Grafting of a Portion of the Tibia for Tuberculosis.—In August, 1911, a boy, aged 16, had the upper two-thirds of his left tibia excised subperiosteally for tuberculosis (*Fig.* 231), the epiphysis being left. Previous to this, two operations (two and three years before) had failed to remove the disease. In August, 1912, a skiagram showed very little bone regeneration, and the leg was useless (*Fig.* 232).

Operation, Aug. 29, 1913.—A strip from the anterior border and surface of the patient's right tibia was placed in the gap of the left tibia and in contact with the freshened ends of the remaining bone, as described by Dr. Murphy, of Chicago (*Fig.* 233). The wound healed by first intention, all except the upper 1½ inches. On removing the dressing for the first time at the end of ten days, the scar tissue over the upper end of the graft was found to be dead for about 1½ inches, and the bare end of the graft was exposed. A dressing was re-applied and left for a fortnight. At the end of this time the slough had separated, leaving the end of the graft bare. This slowly covered up with granulations; none of it was cast off, and the wound entirely healed. Union is firm at the lower, but is scarcely perfect yet at the upper end. There is, however, so little movement

FIG. 233.—One week after operation, showing bone graft in position. The safety pins were in the dressing.

FIG. 232.—Before final operation, showing failure of osteo-genesis.

FIG. 231.—Skiagram showing tuberculous osteitis for which excision was done.

FIG. 236.—Skiagram showing complete restoration of tibia from which graft was taken.

FIG. 235.—Two years after operation, showing restoration of tibia.

FIG. 234.—Fifteen months after operation, showing new bone extending upwards and downwards from graft.

that the limb has to be examined carefully to elicit it, and there can be no doubt that firm union will occur in the course of a few weeks. The new graft can be felt to be enlarged to such an extent that the one tibia now feels as big as the other (*Figs.* 234 and 235).

Twenty years ago, after watching the results of sub-periosteal resection of bone, which was then a fashionable operation, I determined to have nothing to do with it, and remained steadfast to this view until I heard the convincing address of Stiles and noted his results.

In my case the periosteum had been much interfered with by previous operations, and though I took every care to maintain its integrity as far as possible, the result was unsatisfactory, and should be a warning to select suitable cases only for Stiles' operation, and to graft at the time of the resection operation in doubtful ones. *Figs.* 232, 233, 234, and 235 illustrate progress throughout.

Bone-Grafting of Leg Fourteen Years Ago.—*Fig.* 238 shows the skeleton of the leg of a boy, prepared and preserved by Mr. G. Grey Turner.

The patient in 1897 had acute septic osteitis of his left tibia. The diaphysis was removed by the late Dr. Arnison, the ends of it being sawn through close to the epiphyseal lines. In 1899 the wound was completely healed, the epiphyseal ends were present, but there was no trace of intermediate bone. The leg was much deformed.

Operation (Mr. Morison), at age of 16, in 1899. The scar was opened up, and a deep trough made between the anterior and posterior muscles of the leg. The surface of each end of the remaining bone was freshened with a saw, and a portion of the fibula of a young adult whose lower limb was amputated at the same time, was inserted, with its muscular origins and periosteum intact. Numerous holes were bored into the foreign fibula with a drill, and the sawn edges brought into contact with the sawn epiphyseal ends of the tibia. The bone was not fixed with any pegs or wire, because this seemed unnecessary. The entire wound was closed, and healed by first intention.

FIG. 237.—Result of bone-grafting 6 years before.

Six weeks later, the scar broke down at its lower end, and a small portion of the foreign fibula was discharged. A sinus discharged for six months, and then the wound healed.

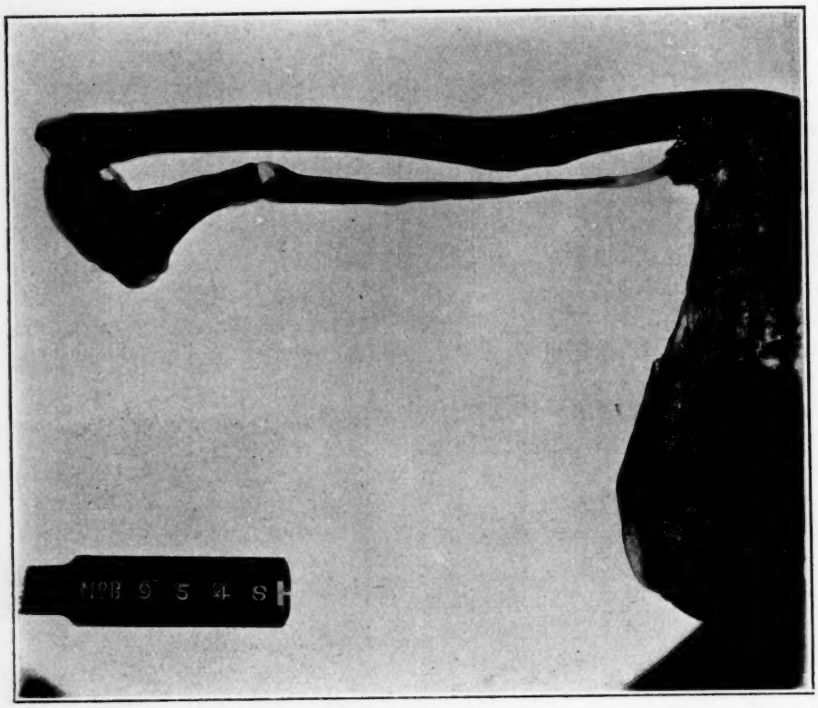


FIG. 239.—Skiagram of skeleton leg.

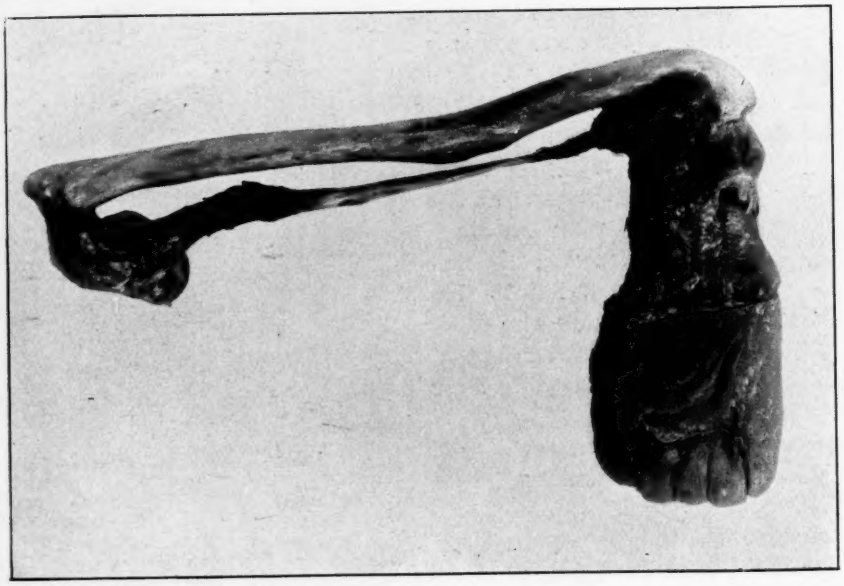


FIG. 238.—Skeleton of leg. Note hypertrophy of fibula and atrophy of transplanted bone.

In March, 1905—six years after the bone-grafting—the leg was amputated through the knee joint on account of failure to grow, and deformity (*Fig.* 237). The specimen showed the foreign bone in position and still containing the drill-holes. It was united by bone to the tibial epiphysis above, and by strong fibrous tissue below (*Fig.* 239). There had been some growth from the upper epiphysis, but very little from the lower. The foreign fibula was not more than a third of the size that it was when the operation was done. The patient's fibula was much thickened and bent, so that the sole of the foot looked inwards. The tuberosities of the tibia sloped from outwards, downwards, and inwards.

Apart from the fact that this operation was done fourteen years ago, it is of considerable interest in the recently revived questions that have arisen in connection with bone transplantation.

FIG. 240.—Chondrosarcoma of humerus.

Bone-Grafting in the Arm.—*Figs.* 240 to 246. This man, aged 25, for nine years had known of a swelling in the shaft of his left humerus; but of late it had grown more rapidly. A skiagram showed this to be a chondrosarcoma (*Fig.* 240).

Operation, November, 1912.—An incision was made, commencing below the clavicle, following the cephalic vein between the insertions of the deltoid and pectoralis major, and down the external intermuscular septum (*Fig.* 245). The lower end of the incision extended to near the external condyle of the humerus. The muscles attached to the humerus were divided about ¾ inch from their insertions, the long head of the biceps being dissected free from its groove. The upper end of the humerus was sawn through obliquely, from the tip of the tuberosity to the lower edge of the anatomical neck. The lower end of the humerus was sawn through transversely at the junction with its middle and lower third, and the intervening part removed. The left fibula was exposed, and the periosteum was separated from it except on the inner side. It was then divided obliquely above and transversely below. Holes were drilled in it, and it was placed in the gap left by removal of the humerus and fixed by Lane's plates to the sawn humerus at the upper and lower ends (*Fig.* 244). The pectoralis major in front, and the latissimus dorsi and teres major behind, were attached to the anterior and posterior edges of the deltoid, the lower end of which was sutured to the divided inner and outer heads of the triceps. The long head of the biceps was attached to the under surface of the deltoid by catgut loops. That these have formed strong attachments can be seen in the photograph (*Figs.* 245 and 246).

FIG. 241.—Six and a half weeks after operation. Graft of fibula attached to lower end of humerus by Lane's plate.

The wounds in the leg and in the arm healed by first intention and without constitutional disturbance.

Three months later, a small blood-stained bleb appeared at the lower third of the arm-scar, and this discharged a small quantity of serum. This had healed from time to time, but was still not sound. When the sinus was open a

FIG. 242.—Three months after operation.

FIG. 243.—Six months after operation. Note separation at the upper end.

FIG. 244.—Showing appearance 10 months after operation. Note drill holes.

probe could be passed to the bottom on to a small area of bare bone, which the skiagram shows to be eroded. [I do not understand the meaning of this, but I have noted it in other cases where a foreign body, even though sterile, had been too close to the skin.] The curious thing is that this sinus has nothing to do with the plate, but is on the fibula, some inches away.

At the end of three months there was complete and apparently firm union at both ends of the bone. I then did a foolish thing, recommending active exercise with dumb-bells to increase the function of the muscles of the arm. Shortly after this was begun we found that the upper end of the fibula had become detached from the upper end of the humerus, and there is still non-union. I am at present waiting to complete the operation by transplanting a portion of the tibia and rejoining the upper end. Even though the patient were left as he is, he has a quite useful arm. He can voluntary flex and extend his arm and fore-arm freely and strongly, and can abduct his arm to about 30 degrees. The movements at the elbow-joint are complete. He is much better off than with an interscapulo-thoracic amputation; but I hope not to be disappointed in making the operation a complete success, because the case seems to be unique, as it has been possible to retain the head of the humerus and the shoulder-joint.

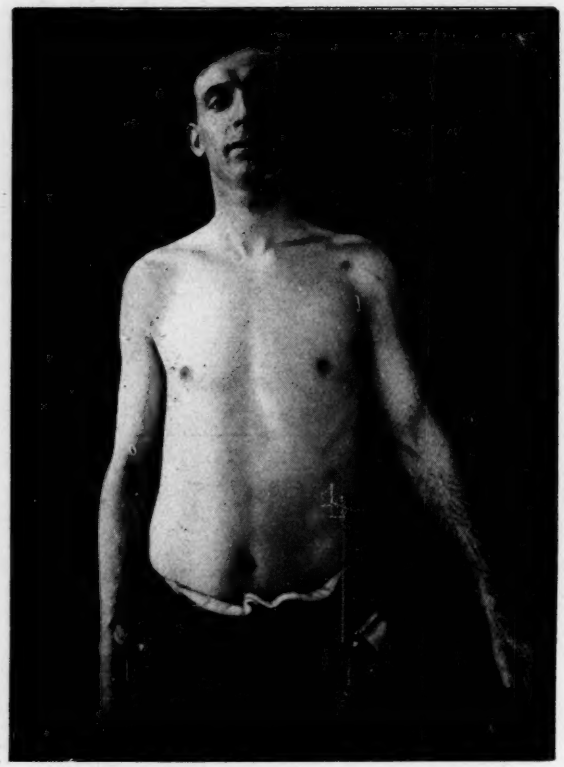


FIG. 245.—Ten months after operation. Shows line of incision.

On examining the arm, the bone seems to be thick, but skiagrams appear to show that it is very little thicker than when put in. There is some callus at the junction of the lower end of the transplanted fibula.

The disappointment of this case has caused me to think. I have asked myself why the fibula naturally is a small bone and the tibia a large one, and the only answer is that the size depends on an " inherent capacity for growth." Dr. Murphy says that the growth of new bone depends on the need for it, and that the amount will equal the functional requirements. The enlargement of the fibula in the skeleton that I have shown gives this view some support, because it has undergone considerable hypertrophy; yet it is very far from being as large as an ordinary tibia would have been. In all Dr. Murphy's cases he appears to have grafted with the tibia, and they show that a graft from the tibia will grow

very large and will certainly fill all requirements, as Dr. Murphy says. There is no evidence that I have seen in favour of the view that an inherently small bone, grafted, will grow into a large one, or will serve as a scaffolding on which a large bone will grow. I raise this point as an important one, because I think I made a mistake in using the fibula instead of the tibia in my patient.

During the last three years in bone operations, I have carried out Lane's excellent technique, with the exception that I use alcohol gauze and corrosive wool for the dressings.

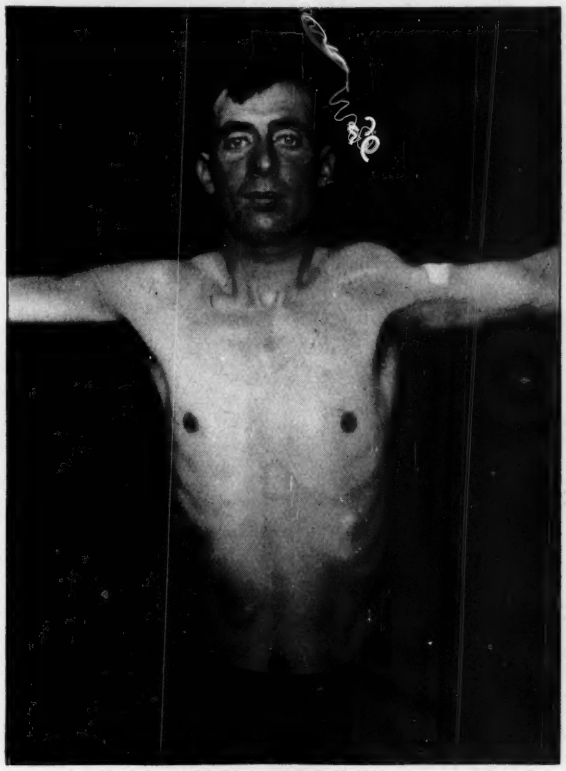


FIG. 246.—Showing muscles in anterior and posterior folds.

Myeloid Sarcoma of Tibia (*Fig.* 247). — This man, aged 42, had a myeloid sarcoma of the upper end of his tibia of seven years' duration and the size of a football.

On *Jan.* 29, 1907, I scooped away the growth, which had destroyed its anterior bony covering, then swabbed the bony cavity that was left with pure carbolic acid, and packed it with towels. At first there was marked deformity, but the immense cavity gradually contracted, until now (six and a half years later), except for the scar, it would be difficult to say which tibia had been affected.

There has been no recurrence.

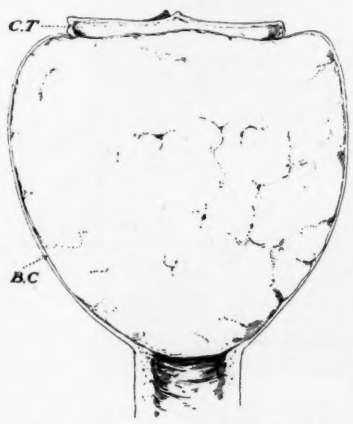


FIG. 247.—*C.T.* Cartilage of head of tibia. *B.C.* Bony capsule. Note extreme thinness of the latter where it surrounds the tumour.

Excision of the Lower End of the Humerus.—The patient, a man, had sustained a backward dislocation of the elbow-joint three months previous to operation, and had a useless arm.

Operation, 1901.—The lower end of the humerus was excised after cutting

transversely across the triceps muscle. The upper end of the radius and ulna were left alone.

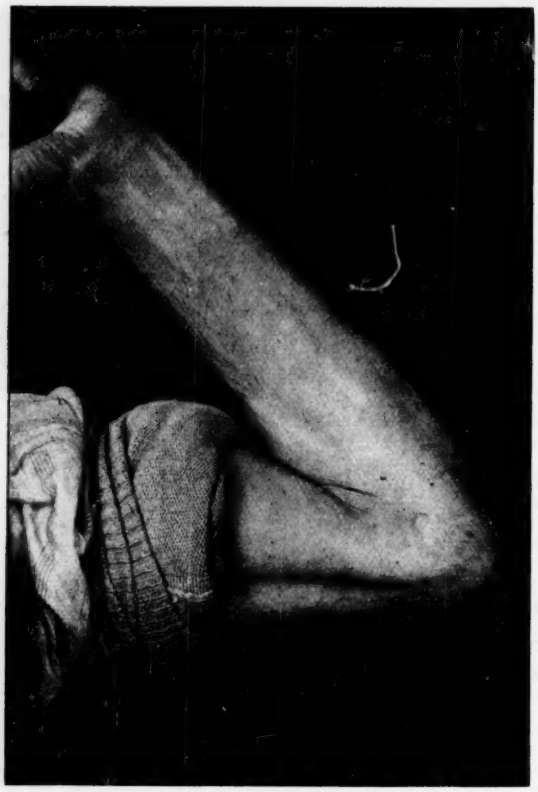


FIG. 248.—Excision of lower end of humerus. Shows full flexure.

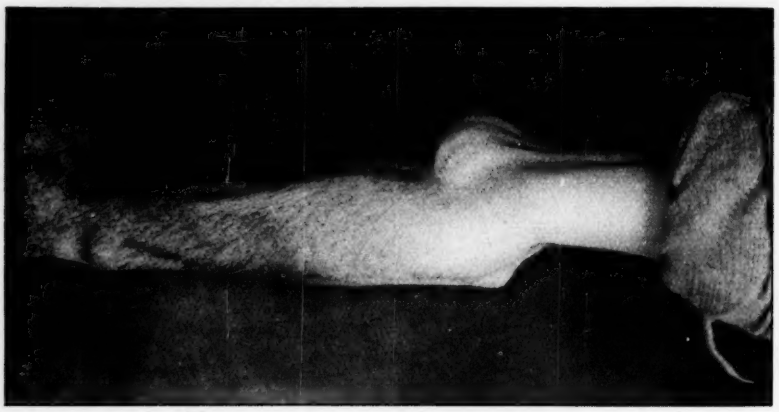


FIG. 249.—Same arm as above. Shows full extension.

The present condition of the man is that he has full movement of the joint (*Figs.* 248 and 249), a very strong arm, and is head gamekeeper of an important

sporting estate, a situation he could not hold if his arm was not more than ordinarily useful. No one there knows of his deformity.

Any physician seeing the photos would say, "This is a typical Charcot's joint," and the radiographs (*Figs.* 250 and 251) would support that view. My object in showing them is to have a chance of expressing a view I hold with

FIG. 250.—Same arm as Figs. 248 and 249 Plate behind right elbow.

FIG. 251.—Same arm as previous figures. Plate on side. Right elbow.

regard to osteoarthritic joints. It is to the effect that the amount of bone atrophy or hypertrophy depends upon the amount the joint is used, and that depends upon the presence or the absence of pain. A painful joint will be an atrophic, a painless one a Charcot's, and one sufficiently painless to function will be of the hypertrophic variety.

THE RELATION OF APPENDICITIS TO "DYSPEPSIA" AND DISEASES OF THE STOMACH AND DUODENUM.

By JAMES SHERREN, London.

Although it has long been known that a relation exists between disorders of digestion and disease of the appendix, it is only in the recent years of surgical activity in the upper abdomen that attention has been systematically directed to the question.

Among the earliest references to this association are those of Talamon[1] and Sir Frederick Treves.[2] The former wrote: "In the periods intervening between the acute attacks, vague abdominal pains often persist, frequent colic, abdominal distention, and painful digestion." The latter: "A large proportion of the subjects of perityphlitis, especially those over the age of twenty, are chronic dyspeptics. . . . Many of these people have a morbid appetite; many of them are aware that an attack is generally preceded by an aggravation of the dyspeptic symptoms."

It was not, however, until 1899 that chronic disease of the appendix was directly associated as a cause of disorders of digestion, and its removal advocated as a cure. In this year Ewald[3] published his paper on *Appendix larvata*. Under this heading he included several groups having the one feature in common that "the pain of which the patient complains leads him and the doctor in the first instance to anything but an illness originating in connection with the appendix." He recorded the history of patients with epigastric pain, heartburn, eructation, loss of appetite, etc., cured by removal of the appendix. In his experience, cases of this nature were uncommon; in the large mass of material that had passed through his hands since 1895, when his attention was first attracted to appendix larvata, only six or seven cases had been brought to his notice.

The first full description is given by Longuet,[4] in 1902, in an excellent paper that has been overlooked by most modern writers. It is a paper to which even now, little can be added.

He recognized the part played by the appendix in the production of gastric disturbance, and named the indigestion cured by removal of the appendix "dyspepsie appendiculaire." It is difficult to find a name more suitable than this. It bears with it nothing beyond the fact that the gastric disturbance is dependent in some way on the appendix.

He divided the cases into two groups, *atonic*, associated with hypochlorhydria, and *hypertonic*, associated with hyperchlorhydria. He gives as probable causes: toxic absorption from the appendix, reflex disturbance, and mechanical interference with the intestine. Beyond these groups and these probable causes it is difficult to go, even at the present time. He records 2 personal cases, and 28 which he had collected. In all, there were local signs pointing to appendicular disease. Of these, 25 were cured by removal of the appendix.

This paper marked a very great advance in knowledge, the full extent of which was not appreciated until the extension of surgical intervention to simple gastric diseases within the last ten or fifteen years.

Although at this time appendicular dyspepsia was not recognized as a clinical entity in this country, the fact that an attack of acute appendicitis might terminate in long-standing dyspepsia was well known to many surgeons and some physicians.

Soltau Fenwick,[5] in his paper on "The Clinical Significance of Gastric Hypersecretion and its Connection with Latent Disease of the Appendix," wrote: "I was, however, well acquainted with a peculiar type of hypersecretion in which death frequently occurred from appendicitis, and was in the habit of warning the subjects of this complaint of their special liability to inflammation of the appendix." He proceeds to state that in 1907, when discussing the subject with W. J. Mayo, "That distinguished surgeon informed me that he had often discovered latent disease of the appendix in persons who appeared to require gastro-jejunostomy, and that the removal of the appendix was followed by subsidence of the gastric symptoms, provided that the alimentary tract was otherwise healthy. Furthermore, that several of his earlier cases of gastro-jejunostomy which he had not materially benefited by the operation, had subsequently been found to possess disease of the appendix, and that when this had been removed a cure had ensued."

It is obvious that the condition was widely recognized in America, for in 1908 Murphy,[6] in his article on appendicitis in *Keen's Surgery*, wrote: "Dyspeptic symptoms are very frequently the prominent feature of chronic appendicitis, and more than one patient is treated for a gastric affection and even operated upon for gastric ulcer."

The year 1910 marks the beginning of the real recognition of appendicular dyspepsia in this country. Three papers appeared drawing attention to the part played by the appendix in digestive disorders—Sir Berkeley Moynihan's[7] in January, Soltau Fenwick's[8] and Paterson's[9] in March. Considerable controversy was excited by Moynihan's paper, which, although somewhat diffuse and neglecting previous work on the subject, states the important points in the history of these cases, five examples of which are given. He drew attention in a forcible manner to the very close mimicry by disease of the appendix, of those symptoms which had long been attributed to gastric ulcer. Features of interest in relation to the character of the pain are given, in the time of onset, association with flatulence, increase by exercise, and occasional hæmatemesis. The symptoms were attributed to pyloric spasm, which he had noted at operation.

Paterson's paper is more precise. Twenty-four personal cases are recorded in which a diseased appendix, but no other abdominal lesion, was found. Hæmatemesis had occurred in 5. The results of gastric analyses are given in 17 cases before operation, and in 12 after operation. Seventeen patients were cured, 3 were satisfactory, and 4 no better.

About the same time, Graham and Guthrie[10] published a most concise account of the dyspepsia resulting from chronic disease of the appendix, founded upon the histories of 200 patients, 115 of whom had been operated upon for a year or more, and 77·4 per cent of whom were cured.

Stanton[11] confirmed the description of the symptoms given by the last-named writers. He based his paper upon a comparison of the symptoms of 51 patients in whom indigestion was cured by the removal of a chronically inflamed appendix, with those of 33 whom operation for acute appendicitis relieved of a long-standing dyspepsia. The character of the indigestion was the same in both groups.

He studied in addition that very instructive group, the uncured cases; these were 36 in number, and he draws particular attention to the patients with right inguinal pain, visceroptosis, and constipation, in whom removal of the appendix had no effect.

These papers establish what is now universally recognized by surgeons interested in the treatment of abdominal disorders, that gastric symptoms which may mimic those of chronic ulcer of the stomach or duodenum, entirely disappear after removal of a diseased appendix. The proof of the causal relationship lies in the indisputable fact that at least 75 per cent of patients operated upon for this condition, the majority of whom have been treated medically for long periods, are absolutely cured of their indigestion. Cases have also been recorded by Paterson and by W. J. Mayo, in which gastrojejunostomy had been performed without relief for gastric symptoms, which were cured later by appendicectomy. A similar case is recorded by Solieri,[12] a man of 32, whom gastrojejunostomy had failed to cure of his symptoms, recovered completely after an attack of acute appendicitis for which his appendix was removed.

There still remain the very important questions of the relationship of the appendix itself to the symptoms, their causation, and relation to intestinal stasis.

With regard to prognosis, it has been my experience that cases presenting similar changes do very differently, and it is, as I hope to show, still an open question if the changes in the appendix itself are the cause of the symptoms in many of the cases.

Before discussing the views of others as to the causation of appendicular dyspepsia, I wish to present my personal experience of the disease and its operative results. I shall divide the cases into two groups:

(I) *Patients operated upon for intractable indigestion in whom, after the upper abdominal organs had been explored, the appendix was removed.* In this group there were no local symptoms or physical signs indicating disease of the appendix;

(II) *Patients operated upon for chronic appendicitis who had been the subjects of dyspepsia.* As in a lecture recently delivered,[13] I am using the term chronic appendicitis in its clinical sense.

Before discussing the question of the first group, there is a fact of the utmost importance in relation to this condition that has to be borne in mind, namely, grossly enlarged appendices—often with stricture and retention of mucus or pus—are frequently met with without giving rise to gastric symptoms; in fact these are usually absent. During the past three and a half years I have operated upon 76 adult cases of this type, 45 of whom were men. In only 1 was indigestion a prominent feature for which the operation was performed; 18 had had only slight indigestion.

GROUP I.

These number 81, 46 of whom were men. I have been able to investigate the after-condition of 52 operated on more than twelve months. Of these, 36 are absolutely well, and have had no further return of their indigestion; 6 are almost well, and complain only of a little flatulence at times; of these, 1 has been cured of the frequent attacks of vomiting from which he previously suffered; 2 are "better."

The following are examples of this group:—

Case 1.—Mrs. E. M., aged 55, was sent to me in June, 1910. She gave the following history. Twelve years previously she had an attack of pain two hours after food, lasting for two months, relieved by vomiting, accompanied on two occasions by hæmatemesis. She then remained well for six years, when she had a similar attack. The third attack was the longest, and began six months before I saw her.

During all the attacks she had been treated for gastric ulcer, and her medical man, from the long continuance of her present attack, considered that malignant change had supervened, and sent her to me as a case of carcinoma of the stomach.

Her pain had been from one to two hours after food, was epigastric, had never waked her at night, and for six weeks before I saw her she had had pain in the right iliac fossa.

There was slight tenderness in the right iliac fossa. Test meal gave a normal acidity.

At operation, June, 1910, I found the stomach flabby, without any spasm, and no trace of ulceration or scarring. I removed an adherent, kinked appendix with fibrosis of its tip. She has remained in perfect health since.

In this patient, the symptoms mimicked chronic gastric ulcer, but the pain after food did not have the same regularity that it usually has in that condition, a fact of great importance in the diagnosis.

Case 2.—H. S., a man aged 37, was sent to me as a case of chronic gastric ulcer. He had been quite well till eighteen months before I saw him, when he began to get epigastric pain about half an hour after food, lasting for an hour. The time of onset of the pain varied somewhat, and might be present after one meal on one day and absent the next. During the whole time he had never been free for more than three or four days. There had been no vomiting until three weeks before I saw him; he then had profuse hæmatemesis, followed by melæna.

I found no physical signs in abdomen. The test meal showed free HCl ·22 per cent, total acidity 84.

At operation I found no trace of ulcer of stomach or duodenum, but the pyloric segment of the stomach was very irritable. The appendix was imbedded in adhesions on the outer side of the cæcum, sharply bent on itself, and full of soft concretions.

He at once lost his symptoms, and has had no return of his indigestion.

In this case, the long continuance of symptoms, and their irregularity, associated with the high gastric acidity, favoured the diagnosis of appendicular dyspepsia.

Case 3.—W. H., a man aged 46, was sent to me for operation after recovering from a severe attack of hæmatemesis.

He had had indigestion for fourteen years. With his first attack he was in bed for two months with pain after food, relieved by vomiting. He has never been quite well since. The next severe attack was November, 1909, away from work for a month. He then remained fairly well till July, 1910, when, while going to his work, he was suddenly seized with epigastric pain, followed by hæmatemesis and melæna, which recurred several times. The pain varied in time of onset from five or ten minutes to an hour after food; it was relieved by vomiting, and never woke him at night.

When I saw him in September, 1910, he had been in bed three months, and was extremely anæmic. No definite physical signs in abdomen.

The test meal showed free HCl ·1 per cent, total acidity 58.

Stomach, duodenum, and gall-bladder were normal. The appendix was of the small, fibrotic type, tightly bound down on the outer side of the cæcum.

He has remained perfectly well since operation.

Case 4.—C. W., a man aged 54, was sent to me for operation as carcinoma of stomach. Five years previously he had had indigestion, of which he could not remember the exact details, lasting three months. The pain was epigastric. He remained well till six months before I saw him. He then began to have pain in the epigastrium immediately after food, without vomiting. The pain had been continuous for a month. No physical signs in abdomen. Test meal showed free HCl ·13 per cent, total acidity 60.

I found the stomach, duodenum, and gall-bladder healthy. Appendix on outer side of cæcum very adherent, and kinked at its tip. On cutting into it, it was completely obliterated.

Three years later his doctor writes: "He is quite well, and has remained free from indigestion since his operation."

Case 5.—H. S., a man aged 43, was sent to me for operation as carcinoma of stomach in January, 1911, with the following history.

Always dyspeptic, with a feeling of fullness after food, accompanied by occasional vomiting. This had been worse for twelve months. The symptoms were very irregular. Test meal showed free HCl absent, total acidity 35.

At operation, Jan. 4th, 1911, the stomach was healthy. Appendix small and fibrotic.

He has lost his indigestion entirely, and complains only of constipation, from which he suffered previously.

Case 6.—J. C., a male, aged 34, had suffered from attacks of indigestion for fourteen years, about three a year, each lasting three months, with perfectly free intervals. The pain comes on about an hour after food, starts in the epigastrium, passes down to the right iliac fossa, and lasts until he vomits. Never wakes him at night. During the attack, he may go a day or two without pain.

Test meal showed free HCl ·23 per cent, total acidity 76.

The stomach was irritable in the pyloric segment; but it, with the duodenum and gall-bladder, were otherwise healthy. The appendix was not adherent, but was almost obliterated.

He writes twenty months later: "I am very pleased to say that since my operation I have been a different man; no trouble whatever with my digestion."

Eight have received not the slightest benefit from the operation. In 1 patient only, a woman of 36, was visceroptosis and intestinal stasis well marked; this is a case my present experience would have excluded from simple appendicectomy. Of the remainder, 5 were men. One of these had had, with his attack of abdominal pain, giddiness and headache. I removed an appendix which was strictured an inch from its tip, and beyond this contained pus. In another patient, the appendix was grossly thickened, with an almost complete stricture an inch from its tip and a concretion beyond. The other appendices were of the fibrotic, adherent type. In none of these patients were pericolic membranes or ileal kinks noted.

Free HCl was absent in 3, in 2 it was present in excess (·22, total acidity 81, ·16, total acidity 69), in 2 normal, in 1 (the patient with the marked intestinal stasis) no test meal was given.

In 5 of these patients I am unable to give any reason for the failure to cure. In all, other causes of indigestion, such as urinary, pulmonary, and nervous disease, were excluded. They can be matched as to symptoms, condition of appendix, and test meal, with patients who experienced complete relief from appendicectomy.

GROUP II.

We turn now to the second group—cases of appendicitis operated upon for attacks of abdominal pain diagnosable as due to the appendix—in whom there was a history of long-continued indigestion. Of 42 operated upon more than a year ago, 7 were during the first acute attack. All have lost their previous indigestion. Of the remaining 35 cases, 29 are cured, 3 much improved, 3 no better.

In the second group, the dyspeptic symptoms resembled in every respect those in the first, in whicb no local signs had been present.

The following are examples :—

Case 7.—A. T., a woman aged 28, was sent to me fourteen days after an acute attack of appendicitis. Nine years previously she was treated for gastric ulcer, and in this attack had hæmatemesis. Since then has suffered from pain fifteen to thirty minutes after food at irregular intervals. Two previous attacks of appendicitis in March and April, 1910.

I removed a fibrotic appendix which was almost obliterated, August, 1910.

Three years later she writes : "I do not have indigestion at all now: it is quite a relief to be free from continual pain."

Case 8.—D. H., a man aged 50, was admitted into the London Hospital in November, 1910, diagnosed perforated gastric ulcer.

He had been having attacks of indigestion for twenty-five years; pain at varying time after food, relieved by occasional vomiting. He was attending the medical out-patient department for an attack which started fourteen days previously. Twenty-four hours before I saw him, he was suddenly seized with severe epigastric pain.

I saw him with general abdominal rigidity. Temperature 103°, pulse 84.

At operation, the stomach and duodenum were normal. The appendix was bound down by adhesions close to the cæcum, and gangrenous beyond. He made an uninterrupted recovery, and has remained quite free from indigestion.

Case 9.—Miss J., aged 40, had a definite attack of acute appendicitis, for which she was in bed fourteen days, two months before I saw her.

For eleven or twelve years she had pain, sometimes directly after food, sometimes an hour after, and occasional vomiting which would relieve it. Hæmatemesis on several occasions.

Definite deep tenderness in right iliac fossa.

On October 20, 1910, I removed an adherent appendix with its lumen almost completely obliterated.

She writes two years later: "I have not had indigestion since."

These series of cases bear out the previous contention, that certain gastric conditions depend for their origin on disease of the appendix, which may or may not have given localizing signs. These symptoms are entirely cured by its removal in 70 to 80 per cent of the cases. The percentage of cures is higher in the second group, but still there are failures.

I believe the continuance of symptoms is most often due to intestinal stasis,

for in two cases attention to the bowels and an abdominal support relieved them. Stanton's experience also points in this direction.

With regard to the condition of the appendix, of the 35 cases which were not in the acute stage, only 11 showed grossly thickened and strictured appendices; the remainder were of the adherent fibrotic type.

During the period from which these cases were drawn, I operated upon 60 patients with grossly thickened appendices—only the 11 mentioned above had had any indigestion. Among 42 patients during the same period from whom I removed the other type of appendix, 31 had had indigestion.

Among the 81 patients with appendicular dyspepsia, in 16 only was the thick type of appendix found; in the remainder it was the fibrous, obliterative, and adherent type.

I have been able to find no difference whatever in the symptoms associated with each type of appendix. Symptoms mimicking duodenal ulcer with a high gastric acidity may be found with a thin fibrotic appendix, or with a thick strictured one containing pus. Hæmatemesis may also occur with each, although it is much more commonly met with in the thin type. It was present in 10 cases, 5 of them operated on over a year ago, and all included in the list of cures.

Soltau Fenwick noted in his cases: "When the appendix is in a state of active irritation, such as ensues from ulceration of its mucous membrane or the presence of a calculus, pain is always a noticeable feature, and a gastric analysis shows both hyperacidity and moderate food-retention. On the other hand, if the appendix is merely thickened or adherent, owing to a former attack of acute inflammation, the symptoms of the gastric disorder are identical with those of chronic inflammation of the stomach, and subacidity with an absence of free HCl, is the rule."

I have been unable to confirm this observation. In 56 of my cases in *Group I*, test meals were given; in 16, acidity free and total was raised; in 7 only was it greatly so; in 27 it was subnormal, free HCl being absent in 18. In the 7 cases, the HCl content and the total acidity, as estimated by Panton and Tidy[14] by the method they have published, were as follows:—

Free HCl ..	·22	·23	·22	·3	·15	·16	·17
Total Acidity ..	84	76	81	98	70	78	76

These figures are comparable to those obtained in cases of chronic duodenal ulcer. With regard to the condition of the appendix, in all but 2 it was of the obliterative type.

Among all the cases operated upon, ileal kinks were discovered in 16, with every type of appendix; in 4 it was of the thickened type, the remainder were fibrotic. Seven of the patients had had no indigestion.

It is difficult to find one theory which will explain the fact that dyspepsia which may be recognized as of the appendicular type, or which may mimic, although not exactly, the symptoms of chronic gastric or duodenal ulcer, may be met with and be cured in patients from whom appendices so different as the thin fibrous cord and the appendix the size of a thumb, strictured and full of pus, have been removed.

The hypotheses enunciated by Longuet are still those which hold the field:

1. *Mechanical interference with the intestine.*
2. *Reflex disturbances.*
3. *Toxic absorption from the appendix.*

W. J. Mayo and Moynihan incline to the view of reflex pyloric spasm. Paterson is of opinion "that intestinal stasis rather than pyloric spasm is the condition in these cases."

With regard to the third theory, that of toxic absorption from the appendix, this may be dismissed as the cause of most of the cases. It is impossible to conceive toxic absorption from a thin appendix, partly obliterated into a fibrous cord, being the exciter of indigestion or profuse gastric hæmorrhage. Even in the cases where toxic absorption might occur in which the strictured appendix contained pus, hæmatemesis is unusual (out of 10 cases, 1 only).

I believe that there are two groups of cases: (1) Those in which the symptoms are the result of irregular action of the pyloric segment of the stomach; (2) Those in which the symptoms are the result of ileal obstruction.

1. In these cases, the pyloric end of the stomach is seen at operation to be irritable, often reddened; they are usually associated with an excess of acid in the test meal, but not with any particular type of appendix.

2. In these, a flabby, often prolapsed stomach, with a widely patent pylorus and large duodenum is met with; it is more common in women, and is usually associated with a low acidity. This is, I believe, due to intestinal stasis, the result of reflex spasm at the ileo-cæcal valve or interference with the lower ileum.

Of the 16 cases of high acidity, 12 were men; of the 18 in which free HCl was absent, 11 were women. The difference in test meals is not noted in other diseases, such as chronic duodenal ulcer, in which the test meals are comparable in both sexes. Paterson[15] considers the absence of free HCl the result of absorption of toxins from the alimentary canal. I have been able in 6 cases to confirm his observation that in cases in which free HCl is absent before operation, it may return within a short time.

The operative findings and the test meals lead to the conclusion that under the heading of appendicular dyspepsia, at least these two types of cases occur, cured by the removal of a chronically-inflamed appendix.

Failure to cure has meant failure to relieve the causative condition, the pyloric spasm on the one hand, the intestinal stasis on the other.

It is obvious that the sole cause cannot be that the appendix is diseased, for I have shown in my figures how often and how grossly this may occur without giving rise to dyspeptic symptoms. That these occur most often with an appendix that is astonishingly innocent-looking, appears to be proof that reflex interference with the action of the stomach, the result of spasm in the region of the ileo-cæcal valve in some cases, mechanical in others, or intestinal stasis, must be the cause of the symptoms.

Turning now to the other side of the question, the relationship of diseases of the appendix to gastric and duodenal ulceration: that there is some close and probably causative association is certain. It is my custom, in all cases of chronic appendicitis with gastric symptoms, to explore the upper abdomen, even although the appendix is grossly diseased. In this way I have been able to deal successfully with chronic ulcers of the stomach and duodenum which were not diagnosable on the history, or on gastric findings after a test meal.

Thus, among 39 patients in whom this was carried out, who had all suffered from a previous definite attack of appendicitis, I found a chronic duodenal ulcer on two occasions, a chronic gastric ulcer once. This last, and one of the duodenals, were women aged 19 and 24.

I have, in addition, operated upon three men with chronic duodenal ulcer, whose symptoms dated from an acute attack of appendicitis.

Perforation of an acute gastric ulcer during an attack of acute appendicitis has been recorded by Moore,[16] who refers to a case of Matheson's in which hæmatemesis and symptoms of perforation occurred during an acute attack of appendicitis which terminated fatally. This was not, however, confirmed, as no operation or post-mortem was carried out.

So far as I can discover, W. J. Mayo first recognised the frequency with which chronic disease of the appendix is met with in gastric and duodenal ulcer. In 1908, Mahnert[17] drew attention to the frequent association of the two conditions, and considered that gastric ulcer is related to appendicitis in effect and cause in as many as 64 per cent of the cases. He recommended inspection of the stomach in all cases of chronic appendicitis with gastric symptoms.

In 1910, MacCarty and McGrath,[18] reporting on the examination of appendices removed during operations for gastric and duodenal ulcers, show that the percentage with obliterated lumens was greater than in other individuals.

About 1911, the practice of removing the appendix in all cases of gastric and duodenal ulcer was becoming more general. Paterson[19] found " obvious appendicular disease " in 66 per cent of his cases of duodenal ulcer. Moynihan[20] stated that the frequency with which the appendix was found grossly diseased was astonishing, and published drawings of the first cases operated upon in 1911. Burk[21] records the removal of the appendix in 21 cases of ulcer of the stomach and duodenum.

I have removed the appendix in 65 cases of chronic duodenal ulcer. In 4 it was normal; it was grossly thickened in 10, 4 of which were strictured and contained pus; in the remainder it was of the adherent fibrotic type, often resembling those figured by Moynihan. The appendices in 41 cases of gastric ulcer were: normal in 5, of the remainder, 3 were of the thickened type, one being acutely inflamed and containing pus, the remainder adherent and fibrotic.

Looked at from the post-mortem standpoint, during the years 1907, 1908, 1909, 26 acute ulcers[22] of stomach and 4 of duodenum were found at the post-mortem in patients dying of other diseases; in 14 cases, acute appendicitis was the cause of death. In 3 only of these did hæmatemesis occur. Wilkie[23] has found 10 cases of duodenal ulcer in the post-mortem room during a year. In 5 cases there was disease in the appendix, in 5, evidence of pericolitis.

So many cases have now been recorded that there can be no doubt that disease of the appendix is closely associated with the causation of gastric and duodenal ulcers.

In the acute stage, in common with other septic conditions, acute ulcers of the stomach and duodenum may occur, and it is conceivable, in the few cases

in which the symptoms of a chronic ulcer were first noticed after an acute attack of appendicitis, that this was the case.

Bolton's[24] well-known work, a summary of which he gave last year, leaves no room for doubt that acute gastric and duodenal ulcer may result from the action of the gastric juice upon cells damaged by poisons circulating in the blood. He also showed experimentally, that delay in healing could be produced by interference with the motor power of the stomach. Payr[25] considered from experimental work, and also from his operative and post-mortem experiences, that acute gastric ulcers in acute appendicitis are embolic, from thrombosis of vein in the mesentery of the appendix and omentum.

Wilkie,[26] in a recent paper, reviews previous experimental work, and gives details of a series of experiments carried out on cats, showing that emboli may be carried from omental veins and become impacted in the venous plexus of the submucous coat of the stomach, and determine the formation of an acute ulcer. While this may be operative in the acute cases, it does not explain their frequent association with the adherent fibrosed appendix in patients who have had no symptoms referable to that organ.

While admiring Sir Arbuthnot Lane's strenuous advocacy of the cause of intestinal stasis, and acknowledging our debt to him for elucidating its symptoms, I do not believe that intestinal stasis alone is sufficient to explain the causation of chronic ulcers of the stomach and duodenum, or that its treatment alone is sufficient to be curative. That it is one factor in many cases cannot now be doubted. The type of patient in whom intestinal stasis is present—usually women—rarely develops a chronic ulcer of the stomach or duodenum; however much the symptoms may resemble that condition, chronic ulceration is not present. The test meal of a patient with intestinal stasis alone, shows a low acidity, often with an absence of free HCl.

Chronic gastric and duodenal ulcer is much more common in men. My own recent figures[27] show duodenal ulcer eight times as frequent, and gastric three times. Gastric acidity in chronic duodenal ulcer is rarely below normal unless secondary gastric dilatation is marked. Although marked hyperacidity is unusual in chronic gastric ulcer, low acidity and absence of free HCl is a rarity.

With regard to the frequency with which ileal kink is met with in cases of chronic gastric and duodenal ulcers, I have notes on the subject in 106 cases of chronic gastric and duodenal ulcers. It was present in 9 of the 65 duodenal cases, and in 3 of the 41 chronic gastric ulcer.

The similarity of the type of appendix associated with dyspepsia without obvious gastric lesion, and that removed from patients with chronic gastric and duodenal ulcers, is striking. It is impossible to avoid the conclusion that ulceration is a further stage, or is due to a super-added cause in the latter. In my opinion, it is in the group of patients in whom irregular contractions of the pyloric segment of the stomach occur, that chronic ulceration is liable to appear.

The large group of cases, more common in women, in which there is a low acidity, often with absence of free HCl, do not develop chronic duodenal or gastric ulcer. I believe that the part played by the diseased appendix in disease of the stomach is twofold. It may reflexedly produce pyloric spasm, or may interfere with the lower ileum—directly, or through irregular action of the ileo-cæcal valve—thus producing intestinal stasis.

If either is present alone, we get the first or second type of appendix dyspepsia; if pyloric spasm and septic absorption, either from intestinal stasis or the appendix itself, co-exist, we have the necessary factors for the production of chronic ulcers.

REFERENCES.

[1] *Appendicite et Périty phlite*, Paris, 1892, 152.
[2] *Perityphlitis*, 1897, 21.
[3] Von Langenbeck's *Archiv. f. klin. Chir.*, Bd. 60, S. 80.
[4] *Semaine Méd.*, 1902, 185.
[5] *Proc. Roy. Soc. Med.*, 1910, iii, No. vi. Surg. Sec. 177.
[6] *Keen's Surgery*, iv., 759.
[7] *Brit. Med. Jour.*, 1910, i, 241.
[8] *Loc. cit.*
[9] *Proc. Roy. Soc. Med.*, 1910, iii, No. 6, Surg. Sec. 187.
[10] *Jour. Amer. Med. Assoc.*, 1910, March 19.
[11] *Ann. Surg.*, 1911, 813.
[12] *Centr. f. Chir.*, 1913, No. xl., 1568.
[13] *Clin. Jour.*, 1913, Sept. 24.
[14] *Quart. Jour. Med.*, 1911, iv, July, No. 16.
[15] *Brit. Med. Jour.*, 1913, ii, 1088.
[16] *Lancet*, 1910, i, 103.
[17] *Mitt. a. a. Grenzgeb. der Med. u. Chir.*, 1908, Bd. xviii, 469.
[18] *Ann. Surg,*, 1910, Dec.
[19] *Lancet*, 1911, i, 97.
[20] *Lancet*, 1912, i, 9.
[21] *Beitrage z. klin. Chir.*, 1911, Bd. lxxvi, 638.
[22] SHERREN, *Choyce's System of Surgery*, ii, 342.
[23] *Brit. Med. Jour.*, 1912, ii, 1285.
[24] *Ibid.*, 1288.
[25] *Münch. med. Woch.*, 1905, No. 17.
[26] *Edin. Med. Jour.*, 1911, N.S. 6, 391.
[27] *Berl. klin. Woch.*, 1913, No. 28.

A CASE OF THYROID TUMOUR OF THE CLAVICLE TREATED BY OPERATION.

By S. B. RADLEY, Congleton,

and

W. DUGGAN, Altrincham.

We are indebted to Mr. Thorburn for his kind permission to publish this case. The condition is apparently one of considerable rarity, the pathology is obscure, and the remarkable functional result is also worthy of record.

The patient, a muscular, healthy-looking cabinet-maker, aged 46, was admitted to the Manchester Royal Infirmary in October, 1912, complaining of a painful swelling in the right shoulder. He stated that he had first noticed a small nodule at the site about six months previously, which had since grown steadily to the size of an orange. His chief complaint was of limitation of all movements of the shoulder, any attempt to raise his arm above the horizontal or to throw it across the chest being associated with considerable pain.

His previous health had been good, but in September, 1910, a small adenoma (?) had been shelled out of the thyroid isthmus by Mr. Telford, of Manchester.

Condition on Admission.—A short median scar was present over the isthmus of the thyroid. Over the middle two-thirds of the right clavicle was a prominent swelling, roughly spheroidal, and about four inches in diameter; the edges were well defined, the surface was smooth and regular, and the consistence was tense and firm in all parts.

The tumour showed visible pulsation. The skin was not adherent or discoloured, and no dilated veins could be seen. The mass was firmly attached to the clavicle, which appeared on palpation to pass through the growth. The radial pulses were equal and synchronous. There was no evidence of involvement of the brachial plexus, and no muscular wasting or paralysis was found. Movement of the arm was considerably impeded by the bulk of the growth, the shoulder joint being apparently normal. He could not raise his arm above the horizontal, nor bring it fully across the chest.

The thyroid gland appeared normal in size, consistence, and mobility, with no evidence of malignancy, and the previous operation had resulted in a perfect scar.

An *x*-ray photograph of the growth demonstrated its clavicular origin. A gap of about three inches occurred in the continuity of the bone corresponding to its course through the tumour. No bony spicules or mottling of the mass could be detected, the osseous tissue being entirely replaced by neoplastic formation.

Operation.—A total excision of the clavicle was performed by Mr. Thorburn. A semicircular incision was made from end to end of the clavicle with its convexity downwards, and a flap of skin and subcutaneous tissues was turned upwards to give a free exposure of the whole bone and tumour. After division of the bone at either side of the tumour, the latter was carefully separated from the deeper structures, and removed. Hæmorrhage, hitherto severe from the vascular surface of the mass, ceased after the vessels entering the mass had been caught. The outer and inner ends of the clavicle were disarticulated, vessels ligated, and the skin flap replaced and sutured. A counter-opening for drainage was made at the posterior aspect of the wound, and a tube inserted.

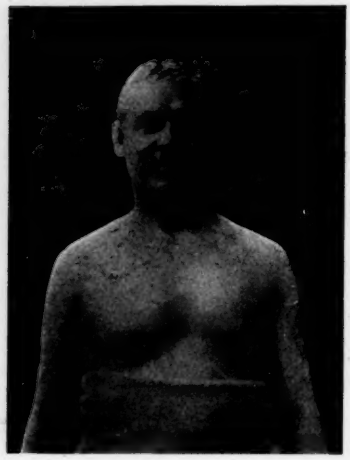


FIG. 252.

Post-operative collapse was marked, but the patient rapidly responded to the usual treatment, the beneficial effect of pituitary extract on the blood-pressure being especially noticeable. The drain was removed in twenty-four hours and the sutures on the eighth day, the wound healing perfectly. The accompanying photographs (*Figs.* 252, 253, 254), taken fourteen days after operation, show that the patient could then raise his arms unaided to a horizontal and vertical position. The plates had an exposure of four seconds, so that the muscular power was, even at this early date, quite remarkable. The only deformity was a slight drooping of the shoulder, which could not be detected when the patient was clothed.

When he left the hospital on the eighteenth day, all movements of the arm and shoulder were good, and increasing in power.

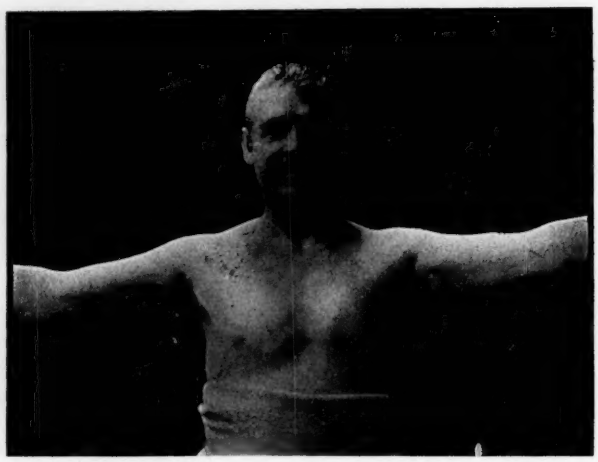


FIG. 253.

Description of the Tumour after Removal.—The growth was of a dark brownish-red colour, the size of a large orange, soft in consistence, and very vascular. On section some small cystic spaces were visible to the naked eye. No bony spicules or calcification could be found.

The histological report was as follows: All the sections show the same structure; the appearance is that of a secondary carcinoma, with both solid

and tubular acini. It more closely resembles a secondary thyroid carcinoma than any other growth, although colloid material is absent.

The accompanying microphotographs (*Fig.* 255, *A* × 200 and *B* × 100) clearly illustrate the characteristic acinar arrangement. Dr. Loveday who, made the histological examination, also tested the growth for the presence of iodine. These tests were negative, but they were performed after the tumour had been in formalin for three months. The patient, on examination six months after operation, expressed himself as feeling in perfect health, with no sign of any local recurrence at the site of operation, and the thyroid was normal. He was following his occupation as a cabinet-maker without any disability, and the movements and power of the arm were perfect.

FIG. 254.

Remarks.—There are points of great interest about this case to which we should like to draw attention: (1) *The rarity of the condition;* (2) *The exact pathological nature of the neoplasm;* and (3) *The operative result.*

1. We have only been able to obtain one other account of a similar condition within recent years,[1] and this author mentions two other cases,[2] which he had noticed in the literature of the subject. Doubtless there are other records of similar cases, but the condition is certainly rare.

2. The pathology of the case seems obscure. Admitting that the tumour is of thyroid origin—an opinion justified by the macroscopic and microscopic appearances—we have to explain the reasons for its growth at this site.

In this case a diagnosis of a secondary thyroid tumour was made previous to operation, and in doing so Mr. Thorburn brought forward the following facts: The patient had evidently some tendency to thyroid hyperplasia, for he bore the scar of the previous operation for removal of an adenoma. The tumour was markedly pulsatile, and was proved by the radiograms to contain no bone in its structure, the clavicle being, in fact, destroyed for about three inches. But that it was not a typical thyroid metastasis was equally evident, for although no histological examination of the adenoma was made after the previous operation, any suspicion of malignancy could be definitely excluded by the following facts: The adenoma was easily shelled out; there was no local recurrence, the thyroid being now perfectly normal; and a careful examination failed to reveal any dissemination throughout the body except for the solitary tumour of the clavicle.

In discussing the case since the operation, Mr. Thorburn has told us of an interesting case which he saw recently in Vienna. A tumour, removed by operation from the upper end of the humerus, was proved on examination

to consist of typical adrenal tissue. The patient, five years after operation, was found to have no signs of any suprarenal trouble and no recurrences elsewhere.

Here, then, are two cases of secondary growths of glandular organs, where the organs themselves are evidently not malignant and the growths solitary, occurring in bone in each case.

M. Guibé[1] concluded that his case was of congenital origin, and suggested that it was an intra-osseous inclusion of a thyroid " rest." As in our case, he failed to find iodine in the secondary clavicular tumour, but he explains this by

A *B*

FIG. 255.—MICROPHOTOGRAPH OF TUMOUR. *A* × 200, *B* × 100 diam.

the fact that the thyroid gland does not contain iodine until the later weeks of fœtal life.

It is reasonable to suppose that the clavicle during its early development had included an outlying portion of the embryonic, iodine-free thyroid, and that this " rest " had retained its characteristic structure and composition until the sudden accession of growth leading to tumour-formation. Although our case could well be explained on this congenital theory, it would be difficult to account in a similar manner for the inclusion of suprarenal tissue in the humerus as in the case mentioned above.

3. Such authors as we have consulted draw particular attention to the good functional results of total excision of the clavicle ; yet to us it came as a considerable surprise to find that such perfect and early movement of the arm at the shoulder could be obtained. Not only were all movements perfect and muscular power good within fourteen days (*Figs.* 252 and 253), but the dropping

of the shoulder was so slight as to be unobservable when the patient was clothed. Presumably the trapezius, rhomboids, serratus magnus, and levator anguli scapulæ muscles have afforded sufficient power to prevent depression of the shoulder and scapula.

If this is so, it is still curious that the withdrawal of the buttress action of the clavicle should make so little difference to the width and contour of the shoulder. These effects, and the movements of the shoulder, are well seen in the photographs.

REFERENCES.

[1] Tumeur de la Clavicule d'Origine Thyroidienne, M. M. Guibé and M. F. Legneu. *Bull. et Mém. de la Soc. de Chir. de Paris,* Fev. 2, 1909.

[2] *Rev. de Chir.,* xxxviii, 343. Estor et Massabuan. *Thèse de Zürich,* 1906–1907. alpérine.

LITHOLAPAXY: ITS EVOLUTION, INDICATIONS, AND CONTRAINDICATIONS, WITH A RECORD OF CASES.

By R. J. WILLAN, Newcastle-upon-Tyne.

The stages in the evolution of the lithotrite are briefly traced up to 1878, *when the operation of litholapaxy was introduced by Bigelow.*

A resumé is given of the symptoms and signs of a vesical calculus, together with the indications and contraindications for litholapaxy.

Especial stress is laid upon the necessity of systematically using the cystoscope; (1) *Before operation, to ascertain if the case is suitable for litholapaxy;* (2) *After operation, to prove that no fragment remains in the bladder.*

Some conclusions are deduced from twenty-two consecutive cases successfully treated by this method.

HISTORICAL ACCOUNT.

I do not propose to go deeply into the ancient history of lithotrity, but merely to trace the stages in the evolution of the lithotrite, or rather the evolution of the process of reducing a stone in the bladder to fragments by the crushing operation.

Period before January 13, 1824.—There is some doubt as to who invented lithotrity; but breaking a large stone before its extraction was evidently practised by prehistoric surgeons, for Celsus, in his treatise "De Remedica," recommends the proceeding, though he failed to describe his method of accomplishment. Again, Sucruta, in the "Indian Treatise of Medicine," shows that he clearly recognized the importance of extracting every portion of the stone, for he says: "The doctor must take great pains neither to break nor to chip the stone, for if a single fragment remains, no matter how small, it would gradually enlarge. This is why the surgeon must seize the whole stone and nothing but the stone."

From a phrase taken from an Arab author, Azzahravi, A.D. 1519, it is suggested that lithotrity was known to this people. The following are the words which led to this suggestion: "Let an instrument which they call Mashaba Rebilia be taken and gently introduced into the passage, crush the stone in the middle of the bladder, and should it be soft, it will break and come out." Leroy d'Etoilles denied that the Arabs either practised or knew lithotrity; as to whether they did or not, depends upon the translation of the words "Mashaba Rebilia," for there is no record of how their knowledge was acquired, nor of the instruments they used. Probably the explanation is that the Arabs optimistically foreshadowed the possibility of lithotrity, although they were unable to carry the theory into practice. In the same way, the future possibility of travelling by aviation was recognized long ago, but it is only during the last few years that it has become an accomplished fact. If the Arabs really did practise lithotrity, the process was rediscovered anew centuries later.

Sanctorius, in 1626, invented a hollow tube with three-pronged forceps which

transmitted a stylet with an arrow-shaped head. Haller thought that this arrow-head was to break the stone, whereas it was merely to close the prongs of the forceps. Sanctorius, without suspecting it, therefore conceived a method of lithotrity, which, however, he considered inapplicable. Unfortunately, the drawing of the instrument invented by Sanctorius is quite unintelligible, and it is impossible, from an examination of it, to have any idea of the mechanism which it represents.

Fabrice de Hilden manufactured pronged forceps to extract the whole stone *from the urethra*, but he did not think of applying it to the bladder.

In the literature, reference is made to at least two persons who operated upon themselves: (1) a Monk of Citeaux, who crushed a stone by inserting a hollow tube into the bladder; this transmitted an iron stem which he struck with a hammer, and splintered the stone; (2) Major Martin, who was also alleged to have operated through a hollow tube, reduced the stone to fragments by means of a file. The latter gentleman at any rate did not cure himself, for it is recorded that he died of stone in Calcutta.

Probably Leroy's statement is correct, that, "Up to the beginning of this (the eighteenth) century, no instrument or apparatus by means of which one could crush the stone *in the bladder* had been described by any author; no instance of mechanical destruction of the stone—the surgeon operating—was known."

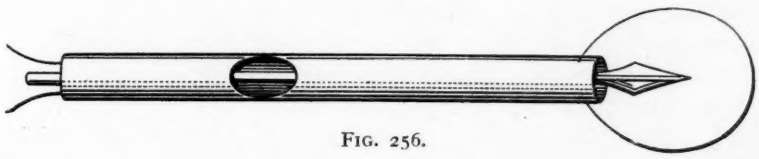


FIG. 256.

Gruithuisen, in 1813, was probably the first really to practise lithotrity. His instrument consisted of a *straight* hollow tube which conveyed a gimlet ending in a spiked crown, or lance-shaped point (*Fig.* 256). In the space between the gimlet and the outer hollow tube passed a brass wire, the loop of which could be projected by the operator into the bladder to lasso the stone. When the stone had been snared, the wire held it firmly against the open mouth of the hollow tube, while the operator rotated the gimlet, which perforated the calculus. It was a dangerous instrument, as the bladder was at the mercy of the spike, but Gruithuisen at any rate showed that the bladder cavity could be reached by a probe of considerable size.

In 1822, Leroy d'Etoilles and Amussat each demonstrated an instrument for the mechanical destruction of a vesical calculus, before the Academy of Surgery in Paris, but each instrument differed widely in principle.

Leroy aimed at destroying the stone by perforating it. He called his instrument the lithoprione; it consisted of two hollow tubes, between which slid four pieces of flattened flexible wire, the inner ends of these being fixed together by a button, making a cage at the bladder end of the instrument. When the stone had been snared in the meshes of the "cage," the wires were pulled taut to fix it, when a gimlet was introduced down the lumen of the inner tube, rotation of this gimlet boring a hole in the stone. Unknowingly, Leroy had rediscovered Gruithuisen's invention.

Amussat's instrument pulverized the stone by combined pressure and friction. It consisted of a straight hollow tube whose lumen acted as a sheath for two strong iron rods (*Fig.* 257). One end of each rod consisted of half a cylinder, this portion of the rods being projected into the bladder, the flat apposing surface of each being fitted with teeth. The other extremity of each of these rods was fitted with several angular teeth, over which a catch attached to the end of the hollow tube slipped; this catch prevented any backward movement

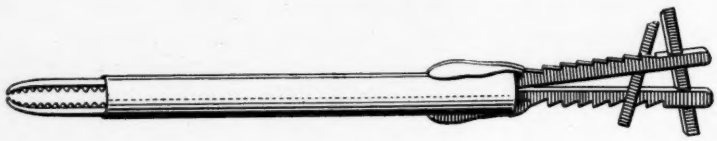


FIG. 257.

of the rod, similar to the modern "ratchet." These two blades were to be projected into the bladder and the stone caught, when each blade was alternately withdrawn to the extent of one tooth. The grasped stone was thus subjected to combined friction and ever-increasing pressure.

Amussat's instrument, though a straight one, was the pioneer of the present-day lithotrite. Unfortunately for mankind, it was not strong enough to crush the stone in the bladder of the cadaver before the Commission appointed by the Academy of Surgery. As Leroy's method of perforation was, notwithstanding its imperfections, fairly successful at this demonstration, it remained in vogue for many years, until it was finally displaced, first by Heurteloup's, and then by Jacobson's modification of Amussat's invention.

January 13, 1824.—The Birthday of Practical Lithotrity.—Upon this date, at the Necker Hospital, Paris, the first public demonstration of the operation of lithotrity was given, the operator being Civiale. The instrument used was a *straight* one.

Civiale, in the previous year, had invented an instrument (*Fig.* 258), consisting of two metal cylinders *A* and *B*, one fitting inside the other. The smaller tube

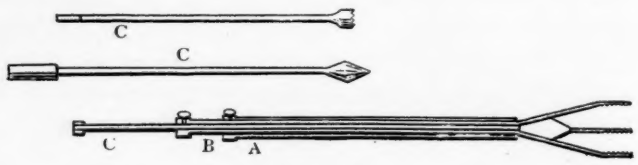


FIG. 258.

had three branches fixed on to its distal end by means of hinges. When the stone had been percussed, the smaller tube was projected into the bladder, its branches being thereby separated from each other, and the action of withdrawing the smaller cylinder into the larger one fixed the stone, when it was perforated by a gimlet *C*. This trilobed pincer was very imperfect, chiefly on account of want of elasticity of the jointed branches.

After Civiale's public demonstration, there was the famous long and bitter controversy with Leroy, for the latter alleged that Civiale had filched his instrument, which he maintained was the first to make lithotrity practicable.

Their method (i.e., the instrument fixed and perforated the stone) was identical, though they differed in detail.

January 24, 1824 to 1878.—*System of Multiple Perforations of the Stone.*—For this method a drill, a drill bow, and a vice (at the bladder end of the instrument) were used. The stone was grasped by the vice, bored, released, and grasped anew. When a sufficient number of holes had been bored, the stone was easily crushed by the vice. Civiale practised this consistently for twelve years. It was not popular with the patient, because seizing the stone was a most difficult and painful proceeding, though Civiale denied this.

Excentric Lithotrity, i.e., the Destruction of the Stone from the Centre of the Stone to the Periphery.—On account of the pain produced by the system of multiple perforations, surgeons, other than Civiale, found it impossible to carry out the operation by this method, owing to the necessity of releasing and re-grasping the stone. It was realized that the stone must be pulverized without having constantly to release and recapture it; therefore Heurteloup popularized excentric lithotrity. His straight hollow forceps held the stone, while his hook-shaped drill with adjustable wings (introduced down the lumen of the forceps) did the hollowing out. The objection to this method was the difficulty in removing the shell of the hollowed-out stone.

Concentric Lithotrity (*i.e., the pulverizing of the Stone from the Periphery towards the Centre*).—Rigal also grasped the stone with forceps, but he rubbed the stone from the circumference to the centre by making the stone rotate in the bladder against the roughened branches of his instrument, which acted as a grater. It proved too painful a method to be practised.

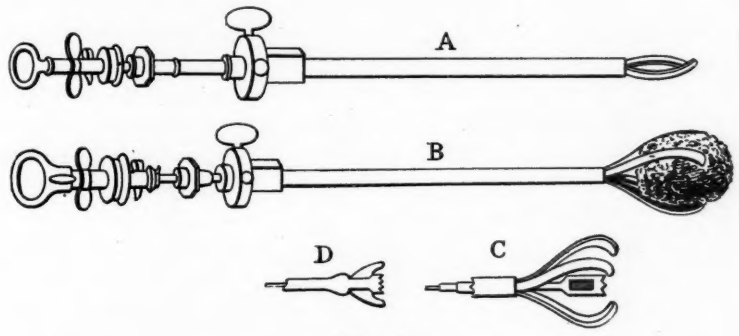


FIG. 259.

Splintering may be regarded as a transition stage between progressive pressure and crushing. The stone was grasped by prongs on the end of a hollow straight tube (*Fig.* 259, *A* and *B*), which was large enough to accommodate a drill. On the sides of the flattened extremity of this drill were two concealed wings capable of expansion by mean of a screw device (*Fig.* 259, *C* and *D*). After a hole had been made in the calculus, the drill was placed in the middle of the stone, and the wings were made to project in an outward direction, when the stone was disrupted by the expanding force.

Division of the Stone by a Screw.—Weiss, of London, introduced a curved beaked instrument. It consisted of two parts, one sliding in a groove in the

other ; between the beaks was a small saw meant to cut the stone by a backward and forward movement.

Crushing the Stone.—Gruithuisen invented an instrument consisting of a strong metal rod, having at one end two diverging branches, which were sharp along the apposing edges, like the blades of a pair of scissors. This rod was drawn into an external straight hollow tube, which determined the approach of the diverging blades to each other. The stone was thus cut, and also tended to be crushed.

Crushing by " Snappers " and a Lever ; Contraction and Friction Combined.—Heurteloup recognized the value of Amussat's instrument and modified it, but his modification was displaced by Jacobson's further modification, which was an articulated stone-crusher.

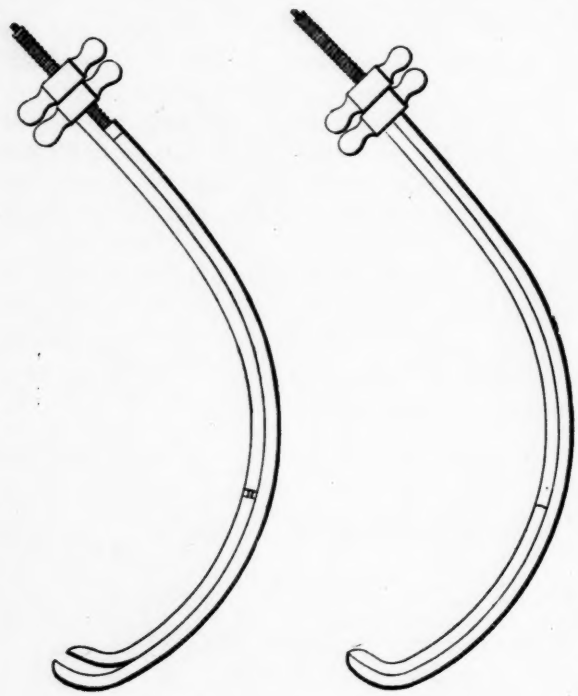


FIG. 260. FIG. 261.

Crushing by the Action of a Screw and Vice.—As applied to the bladder, Leroy in 1823 was the first to think of using the screw and vice in lithotrity. In 1825 Leroy and Retore made an instrument consisting of two curved blades sliding against each other in a groove. The bladder-end of each blade terminated in a beak ; the approximation or divergence of these beaks was accomplished like the action of a vice through the medium of a screw at the opposite, or outer, end of the instrument. (*Fig.* 260 shows the instrument open, while *Fig.* 261 shows it closed.) The stone was to be crushed between the beaks. This was a pioneer instrument, but it broke, and was never used. Leroy did not recognize the value of it, and continued to pulverize calculi by drills.

However, the instrument which was the first to show practically the strength of crushing by the action of the vice and screw was Jacobson's articulated stone-crusher, brought out in 1829. When closed it resembled a large sound slightly curved, and it consisted of an outer silver sheath enclosing a steel rod. The rod was divided into two parts, an anterior immovable one and a posterior movable portion ; these were united at their vesical end by a hinge. *Fig.* 262 shows (*a*) the sheath or body of the instrument ; (*b*) the immovable branch ; (*c c c*) are the joints of the movable branch ; (*f*) is the point of support for the female screw. To crush a stone, the movable portion of the rod was projected into the bladder ; this was withdrawn by means of the screw action of the vice after the calculus had been snared, when the stone was crushed.

It was criticized as being of insufficient strength owing to the numerous articulations. The jointed stone-crusher was the beginning of a new era in lithotrity. Jacobson's instrument, however, was regarded as inferior to Heurteloup's grooved stone-crusher or percussor.

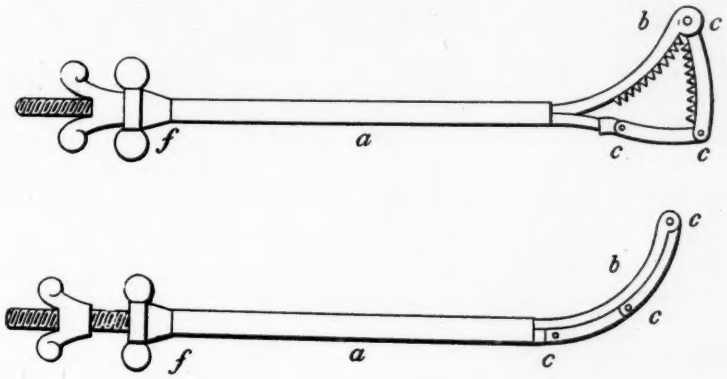


FIG. 262.

Percussion and the Percussor.—Leroy's, Weiss's and Heurteloup's instruments were similar in being *curved* and in having two blades sliding against each other in a groove, i.e., they fixed the calculus in a vice. Heurteloup, in 1823, described his instrument, which deserves special mention, as it was the first to be used satisfactorily for lithotrity; moreover, it is the one, with some modifications, which is in use to-day.

The instrument when closed resembled a curved catheter, and consisted of two blades, a larger female, in which slid the smaller male one. The female blade had a square enlargement on the outer end, and this was firmly fixed into a vice, which was a fixture on a special operation-table. When the curved extremities of the inner end of the instrument were separated, a gap was left; the stone was manipulated into this gap. After the stone had been secured, the

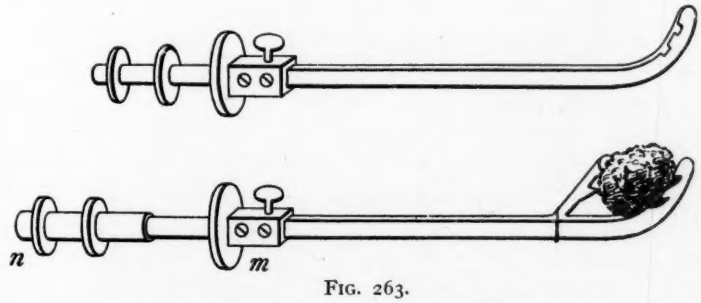


FIG. 263.

female blade was fixed in the vice attached to the operation-table, and the outer end of the male blade was struck sharply with a hammer, which pulverized the calculus. *Fig.* 263 shows the instrument, open and closed; *m* is the square on the female blade, which was held in the vice fixed to the operation-table; percussion was applied at the point *n*.

Crushing by Pressure of the Hands.—Percussion was found to be inconvenient, as it hurt the patient, whose slightest movement injured the bladder; moreover, it took time to fit the instrument to the operation-table vice each time the stone was seized. Attempts were therefore made to crush calculi by simple pressure of the hands; this method was discontinued, as there was too much risk of injury to the bladder when the blades approached each other too abruptly and jerkily.

The next advance was in 1832, when Touzay conceived the idea of fitting a screw to the outer end of the lithotrite, so that the movable blade could be evenly projected towards the male blade. This compressor, or screw, was detachable (*Fig.* 264), and was fitted to the instrument after the stone had been grasped. Later, the compressor became fixed and part of the instrument, and the present system of locking and unlocking the two blades at will was invented.

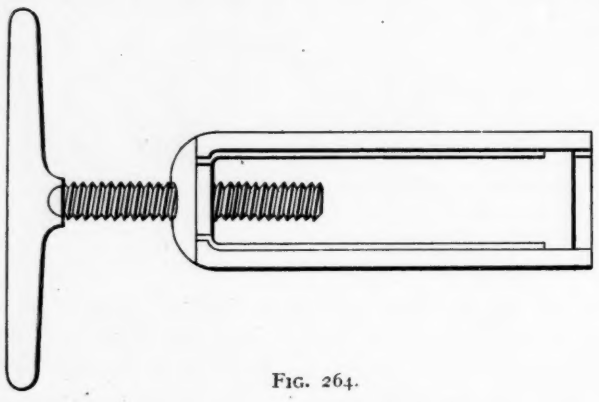


FIG. 264.

After this (1846), surgery went mad inventing new instruments for "perineal lithotrity," new dilators for the prostatic urethra being the most fashionable inventions. Didot had previously suggested perineal lithotrity, but did not practise it, while Bouisson put this theory into execution.

Evacuation of the Crushed Fragments.—In 1843, Cornay, of Rochefort, invented the first aspirator. The essential parts of this apparatus were: (1) A slightly curved sound open at its end, (2) a glass flask, or receiver, (3) a long flexible tube connecting the flask to the sound, and (4) an aspirating pump.

In 1866 Clover's apparatus appeared. The receiver was a pear-shaped vessel made of india-rubber. Its chief advantage was a special method of preventing the fragments of the stone returning to the bladder.

Although neither of these aspirators was efficient, they must be regarded as forerunners of Bigelow's evacuator.

Litholapaxy, 1878.—From the time of Heurteloup up to the time of Bigelow the science of lithotrity had advanced slowly. In 1878 Bigelow introduced the operation of litholapaxy, the name being derived from λιθος = "a stone," and λαπαξις = "evacuation." He crushed the stone and evacuated the fragments at one sitting.

His predecessors lacked two things which prevented them from arriving at perfection in lithotrity: firstly, the use of anæsthetics; and secondly, instruments by which they could empty the bladder of the stone fragments. Bigelow's invention of an efficient evacuator, with the employment of anæsthesia, completely revolutionized the operation for stone, and all credit is due to this American for his ingenuity. *Fig.* 265 shows his lithotrite and *Fig.* 266 his evacuator.

RÉSUMÉ OF SYMPTOMS AND SIGNS.

The symptoms produced by a vesical calculus are usually more severe in children than in adults. This phenomenon is explained by the child's bladder being an abdominal organ; it consequently lies in a vertical position, and the stone therefore tends to engage constantly in the internal meatus when the child is in the upright posture. In an elderly male, the stone may lie in a pouch behind the prostate gland, which effectually prevents it from engaging in the internal urinary meatus.

FIG. 265.

Symptoms of Uncomplicated Vesical Calculus. — *The patient usually gives a history of:—*

Increased frequency of micturition while walking about, but with no deviation from the normal in this respect while he is resting.

Pain along the whole length of the urethra, or at the end of the penis, either towards the termination of micturition, or while walking over rough ground. Severe pain after micturition is often felt in the perineum or in the anus itself. The pain is due to mechanical irritation of the nerve plexus on the sensitive trigone of the bladder.

The patient will often volunteer the statement that stepping on or off the street kerbstone will produce a spasm of pain, more or less severe.

The stream is normal in calibre and force, but there may be sudden stoppages of micturition followed by a return to the normal, with any slight alteration in his position. The severe straining which ensues when the calculus is engaged in the internal meatus sometimes produces incontinence of fæces during micturition, and that patient will consequently have a tendency to hæmorrhoids.

FIG. 266.

Bleeding towards the end of micturition, especially after severe exercise (such as horse-riding), walking over rough ground, or jolting in a moving road vehicle which is devoid of springs.

A history is often given that a child is constantly pulling at his penis to relieve pain felt at the end of the organ, this pain being due to the irritation of the calculus lying on the bladder trigone. As a result of this constant "milking," the penis is well developed.

Symptoms of a Vesical Calculus with Cystitis.—If a vesical calculus is complicated with cystitis which is acute or chronic, then it is often extremely difficult to make a correct diagnosis without the aid of the cystoscope. The symptoms are then like those of a tuberculous cystitis, i.e., in addition to the ordinary symptoms of stone, there are increased frequency of micturition day and night, with more or less pain in the hypogastrium.

Signs.—It is always advisable to ask the patient to micturate, and for the surgeon to see for himself if there are any sudden stoppages, any hæmaturia, the degree of pain, etc. Although uncommon, it is possible for a vesical calculus to be felt on a rectal examination. The urine should be carefully examined for traces of blood and pus.

Priapism is very often a definite sign of the presence of vesical calculus. I recently saw a child aged six weeks where this sign was well marked, and who had a small stone in his bladder.

One can never be quite certain that a stone is present until it is actually seen with the cystoscope, for although radiography is of great use it is not conclusive. Abnormal shadows in the pelvis may be entirely outside the bladder or ureter; again, a stone which is formed of pure uric acid may not throw a shadow.

The bladder sound is rapidly falling into disuse, as it can be very misleading, especially in children where the spine of the ischium may be percussed with the end of the sound, which has on occasions been mistaken for a vesical calculus.

INDICATIONS FOR LITHOLAPAXY.

General Considerations.—In that unique stone number of the *Indian Medical Gazette* (August, 1900), where not only the statistics, but also the operative experience, of famous lithotritists are given, the general consensus of opinion is that litholapaxy is certainly the best operation for the removal of a vesical calculus, and that the knife should only be used as a last resort.

In skilled hands and in carefully selected cases it is a very safe operation. It must be remembered, however, that crushing a stone in a child's bladder is a much more difficult undertaking than in an adult. Therefore, a novice will be well advised if, in his earlier cases, he practises litholapaxy exclusively upon adults.

If a patient has had one calculus, it is more than possible that he will have a further one; the first suprapubic lithotomy is a very easy matter, but not so the second and succeeding operations, where the peritoneum is drawn downwards by the cicatricial contraction from the previous operation; opening up of the peritoneum, especially where there is a cystitis, runs a very serious risk of general septic peritonitis.

Indications.—The operator's armamentarium must include a suitable collection of lithotrites, with aspirators and numerous cannulæ. Vesical calculi which are to be successfully removed by the operation of litholapaxy must be

selected. In this selection the surgeon is largely dependent upon the cystoscope, which should eliminate the complications of :—

1. A marked enlargement of the prostate gland.
2. An encysted vesical calculus.
3. Sacculations of the bladder which cannot be smoothed out by further distention of the bladder.
4. A malignant growth of the bladder.

In the absence of these complications, and provided the patient's kidneys are healthy, a calculus of large size can be safely removed by litholapaxy. A cystitis, however acute, is no contraindication to the crushing, for the inflammation will subside immediately the causative irritant (the calculus) is removed.

Disability.—After a litholapaxy, it is uncommon for a patient not to be able to return to work within seven days after operation.

After a suprapubic lithotomy, he will be lucky if he has sufficiently recovered his strength to do full work again before six weeks have elapsed. If he returns to work too soon, there is a real danger of the scar yielding and of his getting a post-operative hernia. Moreover, even when there is no apparent obstruction in the urethra, a suprapubic sinus occasionally persists for months.

With perineal lithotomy, permanent incontinence of urine sometimes results, owing to damage to the bladder sphincters, either by the scalpel or by the tearing out of the stone.

Recurrence of the Calculus.—A recurrence of the calculus is given as a contraindication for litholapaxy, but there would only be a recurrence if a fragment of stone is left. As it is my invariable practice *always to cystoscope the patient, either immediately after the crushing or before the patient leaves my care,* I can eliminate the possibility of this happening. In the ordinary cases there is no bleeding, and one is able to do this immediately after the litholapaxy.

If hæmorrhage prevents the use of the cystoscope at the conclusion of the operation, I search the bladder by means of the aspirator and cannula as recommended by Freyer.[1] The operator having placed his ear on the patient's hypogastrium, a few compressions of the aspirator are made, and the lotion is propelled along the cannula into the bladder. The returning fluid causes any calcareous fragment, too large to pass, to impinge against the eye of the cannula, which produces an audible " click."

I consider that a recurrence of the stone is quite as common after suprapubic lithotomy as after litholapaxy. Very often vesical calculi only give marked trouble when cystitis has supervened ; if suprapubic lithotomy has been performed where the bladder is septic, it is always wise to employ drainage, and it is wonderfully easy for a piece of ligature or dressing to fall into the bladder and form a nucleus for a further stone. Moreover, if care is not taken after a suprapubic lithotomy to keep the urine acid, especially in the presence of sepsis, a phosphatic deposit adheres to the drainage tube, and fragments of this fall into the bladder, to form the nucleus of another calculus.

CONTRAINDICATIONS FOR LITHOLAPAXY.

Skill in Manipulation.—A surgeon who is not accustomed to the operation of litholapaxy will be wise if he does not attempt to remove the calculus by this operation ; in unskilled hands suprapubic lithotomy is safer.

Enlarged Prostate Gland.—With a marked enlargement of the prostate gland, especially of the middle lobe, I consider it is unsafe to attempt to crush a vesical calculus. It is difficult to catch the stone owing to its being in a post-prostatic pouch; severe bleeding may ensue from damage to a rapidly-growing prostate; moreover, a rupture of the bladder by the lithotrite (an accident which one occasionally hears of) is probably always due to an attempt to crush the stone in the presence of a marked enlargement of the prostate. It is, of course, only possible to accurately diagnose an enlarged middle lobe of the prostate gland by seeing it through a cystoscope.

Encysted Calculus, i.e., a calculus which is encysted in a sacculus in the bladder wall, a portion only of the stone being in the cavity of the bladder. This will be seen in a routine cystoscopic examination.

Sacculation of the Bladder.—If a stone is crushed in a sacculated bladder, fragments of the stone are apt to fall into these sacculi, and not only form the nucleus of an encysted calculus, but they may set up a peri-vesical abscess, due to the sharp fragments perforating the thin wall of the sacculus. In some instances it is possible to smooth out shallow sacculi by further distention of the bladder; in such a case it is quite safe to employ litholapaxy.

Size of the Stone.—A stone of too large a size has been given as a contra-indication; but this, I think, depends entirely on the patient's general condition, and that again depends upon the state of the kidneys. If a patient is in good health, I think even a large stone can be removed by nibbling away at its sides until it is small enough to be caught in the jaws of the lithotrite. Freyer[2] defines a "large stone" as one weighing more than two ounces.

Consistence of the Calculus.—A stone of very hard consistence is especially given by Indian lithotritists as a contraindication for litholapaxy. These hard stones are probably more often met with in India than in this country.

Stricture of the Urethra.—A passable stricture of the urethra is not a contraindication unless there are further complications: for example, a stricture with perineal fistulæ. In this case it is wisest to remove the stone by a cutting operation.

A Foreign Body as the Nucleus of a Stone (e.g., a fragment of catheter, bougie, etc.). If it is known that a foreign body (which is too large to evacuate) forms the nucleus of a stone, it is best to remove the calculus by suprapubic lithotomy.

Age.—Male children under the age of three should have the stone removed by a suprapubic lithotomy, although it entirely depends on the size of the urethra, which is surprisingly large in children.

Stone in the Prostatic Urethra.—A stone lodged in the prostatic urethra which could not be easily pushed back into the bladder should be removed by perineal lithotomy.

Pyonephrosis or Pyelonephritis.—Where renal sepsis is present, it is always wise to do a suprapubic lithotomy in order that free drainage may be established, thereby resting the kidneys as much as possible. A study of the statistics in the *Indian Medical Gazette* for August, 1900, clearly shows that renal disease is very largely responsible for the mortality in litholapaxy.

The symptoms of bilateral renal pain, intense thirst, frontal headaches on awakening in the morning, and loss of flesh, are invaluable evidence of renal insufficiency.

Malignant Growth of the Bladder.—A calculus with a vesical malignant growth is uncommon; when present, it should be removed by suprapubic lithotomy.

AUTHOR'S SERIES OF CASES.

Litholapaxy (including lithotrity) is *not* a common operation. In a search of the case notes of the Royal Victoria Infirmary, Newcastle-upon-Tyne, up to December 31, 1912, I could only find 26 cases where a vesical calculus was removed by the crushing operation. It may be performed in two ways: (1) By urethral litholapaxy, i.e., inserting the lithotrite through the intact natural passages; and (2) By perineal litholapaxy, i.e., making an incision into the urethra in the perineum and introducing the lithotrite through this incision into the bladder, via the prostatic urethra. I have no experience of the latter method, and my remarks in this monograph refer entirely to the former procedure.

Each case was carefully selected; that is, a careful cystoscopic examination was made before deciding upon the crushing operation. Moreover, in each instance, before the patient finally left my care, I satisfied myself with the cystoscope that no fragment remained in the bladder.

Up to date I have successfully performed litholapaxy upon twenty-two cases, two of these being females. In a further case, not included in the series, I crushed a portion of a calculus weighing 12 ounces,[3] but had to complete its removal by suprapubic lithotomy, owing to the bad general condition of the patient, a male aged 60. Had its removal been accomplished entirely by litholapaxy, it would have equalled the record calculus crushed by Milton, of Cairo.

The following are the weights of some of the large vesical calculi removed through the natural passages:—

Milton[4]	12 ounces	Freyer[7]	$6\frac{1}{8}$ ounces
Smith[5]	$9\frac{1}{2}$,,	Smith[5]	6 ,,
Cunningham[6]	8 ,,	Do.[6]	$5\frac{7}{8}$,,
Henderson[5]	8 ,,	At Jaipur Hospital[1]	$3\frac{5}{8}$,,
Smith[5]	7 ,,	Davidson[8]	$3\frac{1}{2}$,,
Do.[5]	$6\frac{1}{2}$,,		

The largest stone I have crushed weighed exactly 2 ounces, a further one being just short of this. Thirteen of the series exceeded 1 drachm; the remaining nine were under this weight, the smallest being 5 grains.

The youngest case was 5 years old, and the oldest 72, the average age being 42.

Thirteen of the cases were *x*-rayed. This examination gave a negative result in two instances, and in each of these two cases a calculus of pure uric-acid consistency was subsequently removed.

Only a small proportion of the crushed calculi have been examined chemically, therefore I have not ventured to state the consistence of the calculi.

Every case I have operated upon by this method has made an uneventful recovery.

For the historical account I am chiefly indebted to Gouette's "Essai Historique sur la Lithothritie," 1893; and to Leroy d'Etoille's "Histoire de la Lithothrite," 1839. The bulk of the illustrations are reproduced from the latter monograph, and I have also to thank Mr. P. J. Freyer for his kindness in allowing me to reproduce illustrations 265 and 266 from his "Modern Treatment of Stone."

REFERENCES.

[1] FREYER, *Ind. Med. Gaz.*, 1884.
[2] FREYER, *Brit. Med. Jour.*, 1896, ii.
[3] WILLAN, *Northumberland and Durham Med. Jour.*, 1913, Sept.
[4] *Lancet*, 1896, i.
[5] *Ind. Med. Gaz.*, 1900, Aug.
[6] *Brit. Med. Jour.*, 1891, i, 1008.
[7] FREYER, *Modern Treatment of Stone*, 1896.

SPLENECTOMY IN EGYPTIAN SPLENOMEGALY.

By OWEN RICHARDS, Cairo.

The literature of splenectomy consists mainly of reports from different surgeons who have operated on one or two cases, and collections of these accompanied by a discussion of the results. The best examples of the latter which I have been able to find are the excellent papers of Armstrong,[1] Torrance,[2] and Johnston.[3]

But it is clear that while such collections possess great value in some respects,

Fig. 267.—These photographs, and Fig. 268, show three stages in the progress of the disease. Note the gradual opening out of the costal angle, and the progressive emaciation. The most advanced case has developed a double hernia full of ascitic fluid.

they have two inherent defects. As one of these authors points out, a surgeon who has only performed the operation once, and has been unfortunate enough to have had a fatal result in that case, is not likely to report it; so that where so much of the literature consists of single cases, any conclusions as to mortality and results drawn from the published material can only apply to a part—and that the most successful part—of the operations actually performed.

Another defect of such records is due to the unsatisfactory nature of our present knowledge of the pathology of splenomegaly. When all the known and understood forms of this condition have been subtracted, there remains a considerable residue of cases, classed together for the sake of convenience as splenic anæmia and Banti's disease, which probably represent several distinct conditions; and if we are to estimate the value of any operation, we must first have a clear idea of what disease it is applied to.

A contribution which meets both these difficulties as far as possible is the remarkable series of cases recently published by Mayo,[4] which consists of twenty-seven consecutive operations from the same clinic. In addition, there are papers on the pathological and clinical side of the same cases by Wilson[5] and Giffin.[6] The whole forms a comparative study of a considerable mass of material at first hand by the same observers. Nine of these cases are heterogeneous, wandering spleen, tubercle, etc. The most homogeneous and, I venture to think, the most interesting part of the series are the 18 cases of the splenic-anæmia group, 8 of which showed changes in the liver (Banti's disease).

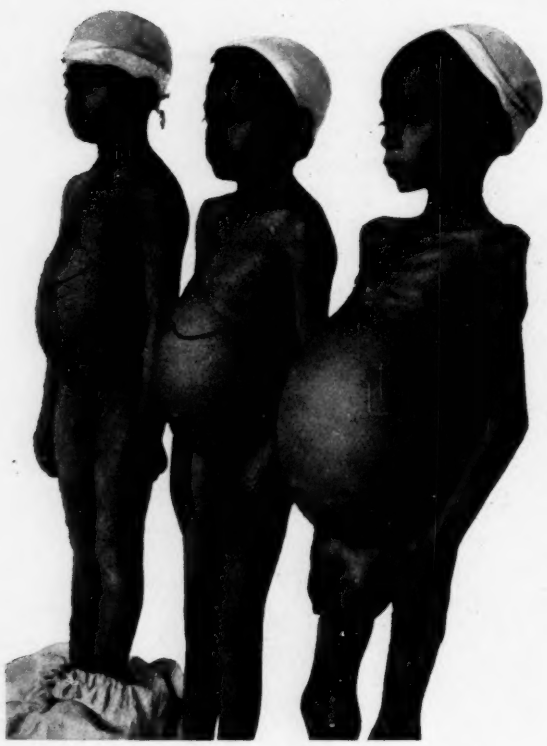


FIG. 268.—The same subjects as FIG. 267.

These cases, clinically uniform, showed considerable differences in their morbid anatomy, and are arranged by Wilson in three classes. But he concludes that it is unnecessary to assume three different causes for their production, and is inclined to think that they are all due to the presence of a slowly acting local toxin. This conclusion is in agreement with the excellent results reported after removal of the diseased spleens.

In Egypt, a disease which produces a very similar clinical and pathological picture is of frequent occurrence. It has already been described in a paper by Day and Ferguson[7] under the title of "Endemic Splenomegaly with Cirrhosis," and subsequently by Day and myself[8] under the name of "Egyptian Splenomegaly." Both these names are purely descriptive and provisional. In its main features it agrees with Banti's disease as this is usually understood, though I have been unable to consult Banti's original paper. But it presents certain marked differences from many of the cases which have been grouped under this heading. It is a very definite and uniform disease, and to call it Banti's disease would lead to its confusion with cases, some of which are probably of quite a different nature.

Possibly, with fuller knowledge, these cases and the greater part of those now called Banti's disease will be given some name derived from their cause. Meanwhile neither name connotes anything except a group of symptoms; but

FIG. 269.

Notes and Photograph by Professor A. R. Ferguson.

Microphotograph of Case No. 8 (about 150 diameters).—The microscopical characters displayed are those shown by the organ in the later stages of the disease. The general dilatation of the vascular spaces is well shown. They are of most irregular form, and in the fresh state are always distended with blood. A large quantity of the contained blood is lost on opening a spleen received from operation. The leucocytes in the sinuses are practically all of the mononucleated variety. Polymorphonuclear leucocytes are exceedingly sparse in the fresh spleen in this disease, and these cells are always notably diminished in the circulating blood during life. There is a considerable development of young connective tissue in the reticulum of the spleen, and a corresponding degree of disappearance of the lymphoid elements proper, the result probably of pressure-atrophy. The Malpighian follicles are reduced in number; those surviving are indefinite in contour, and share in the general fibrosis. This is the case in the particular spleen from which the microphotographs were taken, though the fact is not illustrated in the photographs.

the denotation of Egyptian splenomegaly is at any rate precise, and it refers to a group of cases all of the same kind, and to no others. In this disease splenectomy, of which I am able to report a series of 22 cases, yields excellent results.

The patients who were selected for operation all showed an enlargement of the spleen, anæmia, cirrhosis of the liver, and a low leucocyte count. They ranged between the ages of 7 and 50, but only one case was over 30, and the average age was 20. Few of the patients knew their ages accurately, so these

FIG. 270.

Notes and Photograph by Professor A. R. Ferguson.

Microphotograph of spleen from Case No. 8 (about 400 diameters).—The dilatation of the vascular sinuses and the general cellular fibrosis of the spleen pulp are well seen. It may be observed that many of the newly-formed connective-tissue corpuscles have nuclei of oval or pyramidal form as well as the more usual spindle-shaped type of nucleus. Many of these corpuscles, judging from their form and relation to the vascular sinuses, take their origin from proliferating endothelium. Note the exclusively mononuclear character of the leucocytes lying within the sinuses. The relative disappearance of the lymphoid tissue of the spleen is more strikingly apparent.

figures are only approximate. All except three were males, and they were all of the labouring class.

In nearly all cases they gave a history of attacks of fever, and of splenic enlargement, first noticed after these attacks and gradually increasing, with or without recurrence of the fever. Without exception they suffered from cirrhosis

of the liver, and in advanced cases from ascites. Their anæmia was often aggravated by coincident bilharzia or ankylostoma infection. The complaint for which they sought relief was usually the size of the spleen, and pain caused by adhesions round it. Several were accustomed to provoke vomiting to relieve the pain caused by filling the stomach with food, and one man complained that when he walked about, his spleen swung like the pendulum of a clock. Several had attacks of fever in the hospital.

There seems to be a seasonal variation in the accesses of the disease, for with four exceptions all the cases applied for admission in the six months from March to August, that is to say, in the hot weather.

The condition gradually progresses to ascites, emaciation, and death. Anæmia is never severe enough to cause death, and hæmatemesis is rare. The sufferers die apparently from exhaustion, the result of the long-continued drain brought about by intrahepatic obstruction of the portal system. In favourable cases the disease may be arrested spontaneously, but these patients do not come to hospital, or come for some other reason.

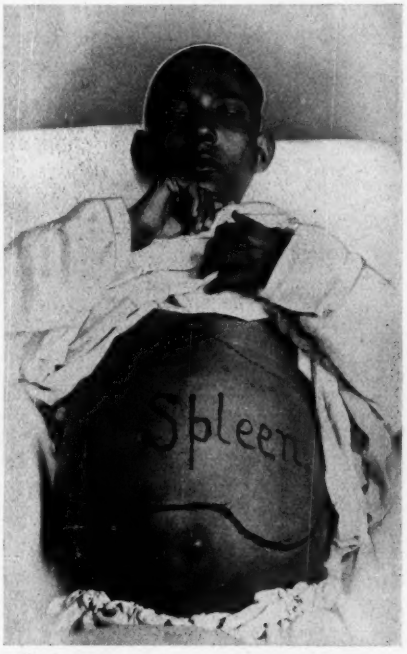


FIG. 271.—*Case* 11.—An advanced case with ascites and jaundice. The boy weighed 6 st. 12 lb., and the spleen over 6 lb. He made a good recovery, but suddenly developed portal thrombosis on the seventeenth day, and died next day.

The illustrations (*Figs.* 267 and 268) give a good idea of the successive stages of the disease.

The patients have not been benefited in any way by quinine or salvarsan; they do not have malarial parasites; and careful and repeated search has failed to reveal any organism of the Leishman-Donovan type.

The nature of the complaint is unknown, and it would be out of place to attempt to discuss it here. Full details will be found in the papers referred to above. The changes in the spleen are a general hyperplasia, that in the liver a multilobular cirrhosis. It is clear that it constitutes a definite and consistent disease, probably of infectious origin. It resembles in many respects the cases grouped by Mayo under splenic anæmia, but differs from them chiefly in the accesses of fever, the seasonal variation, and the early and invariable cirrhosis.

Professor Ferguson has kindly prepared microphotographs (*Figs.* 269, 270) from one of the spleens removed. They show clearly the changes which take place in these cases.

The total number of splenectomies performed for this condition in my section of the hospital is 22, of which 4 were fatal in the sense that the patients died before they left hospital. In 2 cases operation had to be abandoned, and both

patients recovered. These two cases are reported, but of course not counted as splenectomies. No other splenectomies have been performed in my section during the period covered by this series (August 1910 to October 1913).

Of these operations, 5 were performed by my assistant surgeon, Dr. Aly Bey Ibrahim Ramez, who also gave me most valuable help in nearly all the others. I have to thank him for kindly allowing me to include his cases in the series, which thus represents our total combined experience.

The first 11 cases have already been published elsewhere.[8]

Fatal Cases (*Cases* 7, 8, 11, 16).—These are four in number, of which two only (*Cases* 7 and 11) had progressed to the stage of ascites. Each had yielded over six litres of fluid on tapping. *Case* 7 succumbed on the third day, with delirium and coma. *Case* 11 (*Fig.* 271) made an apparently complete recovery, and was transferred at the end of a fortnight to the medical side. On the eighteenth day he developed portal thrombosis, and died very soon. I have since made it a rule not to operate on any case which has progressed to the stage of ascites.

FIG. 272.—*Case* 8.—This patient died of acute dilatation of the stomach.

The third (*Case* 8) died with a typical acute dilatation of the stomach, with copious secretion of a greenish watery fluid (*Fig.* 272). The fourth case sank steadily, and died the next day. He had double chronic pleurisy, a very fatty heart and kidneys, ankylostoma infection, and extensive bilharziasis of bladder, ureters, and rectum. Eggs were also found in the lungs, while the cirrhosis of the liver was periportal and contained calcified ova. I was at first inclined to consider this an error of diagnosis, and that it was a case of enlarged spleen secondary to a bilharzial cirrhosis; but Professor Ferguson is of opinion that the splenic enlargement was too great to be due to this cause, and that the case was really a primary splenomegaly complicated by bilharzial infection. Since 60 per cent of the males between the ages of 5 and 60 dying in this hospital have this infection in some degree, the coincidence is not remarkable.[9]

This mortality, 18 per cent, seems at first sight a high one. If I had been wise enough at the time to exclude the two advanced cases with ascites, it would, however, have been reduced to 10 per cent, and this, I think, about represents the real risk of the operation, when its application is restricted to cases in the

pre-ascitic stage. Mayo, in his series of splenic anæmias, had 2 deaths in 18 cases, a very similar proportion.

It must be remembered that these patients are always weak and anæmic, and often the subjects of other infections and diseases. When the improvement in the successful cases is considered, the risk is not excessive, and with proper selection of cases will probably be slightly reduced. In our last 11 cases there has been 1 death.

The mortality for splenectomies up to 1908 given by Johnston,[3] is 27·4 per cent, and for 61 cases of Banti's disease in the same period, 19·5 per cent. I have already given reasons for thinking that the mortality deduced from published cases is unduly low. In the cases quoted by Armstrong[1] (32 cases, 9 deaths=28 per cent), the cause of death seems usually to have been hæmorrhage and its resultant shock. This risk, always present, can be largely reduced by a careful technique. It has not contributed to the mortality of this series, and the same is true of sepsis.

FIG. 273.—*Case* 1.—This was the first case attempted, and the operation had to be stopped owing to heart failure. The patient recovered, and died at home about six months later. The marks on the abdomen are cautery scars, and represent the native treatment of chronic pain.

Incomplete Operations (*Cases* 1, 9).—In *Case* 1, a girl with an enormous spleen (*Fig.* 273), the heart stopped as soon as I endeavoured to dislocate the lower pole of the spleen. It was induced to begin again by massage through the diaphragm; the abdomen was closed, and the girl made a good recovery, and died at home six months later. Considering her condition, I doubt if death was hastened by operation.

Case 9 had such universal adhesions that removal was found to be quite impossible; the wound was closed, and the patient left hospital a fortnight later. These cases call for no comment.

Successful Cases.—The senumber 18, and were all successful in the sense that the patients left hospital in better condition than they entered it.

As regards their ultimate success, they have all been operated on since March, 1911, so that many of them have only been done a short time. Moreover, it is difficult to keep track of poor patients who cannot read or write, who have no surnames, and many of whom come from remote villages. However, by the aid of the police and backsheesh, two great forces in Egypt, several of these have been induced to come up for inspection once or twice, and four were shown to the local medical society last April.

Six of the first 10 have been seen at intervals varying from two and a half years downwards, and the results have been very satisfactory.

Case 2 was seen eleven months after operation; he was well, and his red blood corpuscles had risen from 1,808,000 to 3,680,000.

Case 4 was seen twenty-three months after operation, and was very well and grateful, living an active life (*Fig.* 274).

Case 5 was seen eight months, and again two and a half years after operation. He had gained 19 lb., or, since the spleen weighed 4 lb., 23 lb. in all. He is now doing full work as a field labourer, which he had been unable to do for some years before operation.

Case 6 was seen a year and nine months after operation, and was doing a fair amount of work, about half a full day; he looked well and cheerful.

Case 14, who had been ill for two years before operation, and

Case 15, who had been under treatment for the same time (including injection of salvarsan) were both shown in good condition nine months later.

FIG. 274.—*Case* 4.—This woman made a good recovery, and was shown well and active at the end of nearly two years.

It is as yet too early to say much about the later cases, but one of them, *Case* 20, is worth mentioning. She was a girl, aged 15, with a spleen weighing over 3 lb., had been ill for more than two years, and had so much pain after food that she used to fast in order to avoid it. She made a rapid recovery, engaged herself as ward-maid in the hospital, and earned her pay at this fairly heavy work till she left after four months in good condition. She is marked in the matron's register as "a good worker."

These results may be summarized as follows:—

Of the first 10 patients who survived the operation, one (*Case* 3) was found to have died at home five months after the operation. There is no information as to how he died; three others (*Cases* 10, 12, 13) could not be traced, dead or alive; six others (*Cases* 2, 4, 5, 6, 14, 15) were all well at periods varying from two and a half years to nine months after operation, and several of them doing hard physical work.

I think it is quite clear that splenectomy in these cases produces a degree of improvement amounting in favourable cases to a cure. And this is quite in accordance with the theory that the disease is a progressive cirrhosis of the liver, due mainly to the presence of a focus of infection in a diseased spleen. On this view the spleen is in fact removed to save the liver. Of course, no operation whatever will give the patient a new liver, which is what he wants to make him a healthy man. But if a patient gets rid of the complaint for which

he comes to hospital, returns to active life, and earns full pay, he may be considered, from a practical or economic point of view, as cured. It is in this sense only that operation is claimed to cure some of these cases. As to the spleen, it has probably ceased to have any useful function long before it comes to operation (*see Figs.* 269, 270).

Diagnosis.—Diagnosis in this country is relatively easy. The clinical picture is a common and definite one. Alcoholic cirrhosis is practically unknown among a Moslem population. Bilharzial cirrhosis is very rare; it only occurs in 4 per cent of all cases with marked infection; moreover, it does not as a rule cause much ascites, and never any great splenic enlargement (Ferguson). Malaria is also very rare, and is excluded by a blood examination such as has been made in all these cases, and which also serves to exclude leukæmia. Though syphilis is common enough, syphilitic cirrhosis is rare, and salvarsan does these patients no good. Repeated examination of the spleen pulp has not revealed the Leishman-Donovan body in any case. Therefore, if cirrhosis, splenomegaly, and a low leucocyte count are present together, I think the chances of a wrong diagnosis are very small. Anæmia is always present, but it is so common here from bilharzia and ankylostoma, that it is of very little diagnostic value.

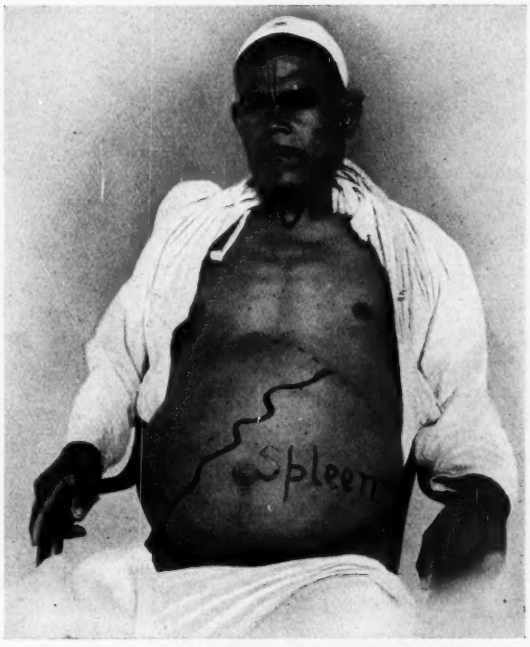


FIG. 275.—*Case* 6.—This patient was shown a year and nine months after operation. He was doing work in the fields.

Selection of Cases.—The first question which arises is, what cases of this disease should be operated on. In deciding this, the state of the liver is the one essential factor. The size of the spleen is of relatively little importance, though of course, the larger the spleen the greater the relief given to the patient by its removal. What kills the patient is not splenomegaly or anæmia, but cirrhosis.

Obviously mild and early cases should always be allowed the chance of spontaneous recovery, and anyhow they seldom apply for relief. On the other hand, the very advanced cases, with ascites and emaciation, are in my opinion unfit for operation. Removal of the spleen cannot cure a cirrhosis which is already so advanced as to be visibly killing the patient, while the shock of the operation and the poison of the anæsthetic are only too likely to hasten the end. Two of my deaths were due to this mistake, and I feel sure that it is a sound rule

never to operate in the presence of ascites. One must draw a line somewhere, if only for teaching purposes, and the occurrence of ascites is a definite landmark in the progress of the vitally important part of the disease, namely, the cirrhosis.

I have described elsewhere[8] my attempts at dealing with the ascites itself by Talma-Morrison operations and Paterson's button ; since they were uniformly unsuccessful, they need not be referred to again. These cases can be relieved by repeated tappings ; in some, the ascites diminishes or disappears in hospital ; but the improvement is usually only temporary, and they die, as a rule, in about six months (Day).

Broadly, one may say that the cases most suited for operation are those with big spleens and big livers, in which the disease is severe and progressive, but which have not yet reached the stage of ascites.

FIG. 276.—*Case* 10.—Weight of spleen about 5 lb. Recovery. Not traced.

Preparation of the Patient.—It is essential to give these patients a rest in hospital in order to establish the diagnosis, discover and treat ankylostoma, and improve the anæmia by drugs and food. Nearly all the cases have been for varying times under the care of Dr. Day before coming to my section, and their general condition has been much improved. *Case* 13, weighing 3 st. 8 lb., gained 4½ lb. in the month which he spent in the medical wards, and was practically converted from an inoperable case into an operable one. He was in any case on the border-line, as he had a trace of ascites, and the successful result was mainly due to his period of preparation, and especially to the expulsion of his ankylostoma worms.

OPERATION.

Surgeons of wide experience in abdominal work may find a detailed description of the technique superfluous, but as these large spleens are rare in England, I think it is worth while to discuss the methods Dr. Aly Bey and I

have found most useful, in the hope that they may be of help to some surgeon who is called on to deal with a case of this kind for the first time.

The difficulties met with differ widely from those in cases of normal or slightly enlarged spleen, without adhesions, which form the basis of the text-book descriptions, and none of these remarks apply to such cases, of which I have no experience.

As regards the incision, a vertical one is the best, starting from a point half-way between the costal angle and the lower border of the thorax, about two or three inches from the middle line. It descends vertically downwards, splitting the left rectus muscle for six or eight inches.

If the incision is placed in the middle line there is not good access to the outer side of the spleen, and it is difficult to bring it out of the incision; if, on the other hand, it is placed further out, the costal margin prevents its being extended high enough to give access to the vault of the diaphragm, where much of the difficulty from adhesions is likely to occur. For the same reason, even if the enlarged liver descends low, as it often does, the incision must still be carried right up to the rib cartilages. A transverse incision added to this is practically never necessary; I have used it only once.

The left rectus is often separated from its fellow, and spread out over the tumour, so that its relation to the incision varies.

The fibres of the muscle are not divided, but its nerves are, and this leads later to a degeneration of the strip lying median to the incision. In *Case* 2, seen eleven months later, this was marked, but the case was one of a small boy, aged 12, and his spleen weighed $4\frac{1}{2}$ lb., so that the incision was necessarily long in proportion to the boy. There was, however, no hernia, even in him, and in the other cases the weakening was not marked, and led to no visible bulging.

Theoretically, this division of nerves is regrettable. But the paralyzed strip is covered by intact sheath, and lies in the upper part of an abdomen which is lax after removal of the tumour, so that practically no harm results from it, even in the cases which do hard work in the fields.

After exposure of the spleen, the first difficulty is that of adhesions. These follow no rule: they may be negligible, or they may bind the spleen so closely to parietal peritoneum, omentum, diaphragm, stomach, and small and large intestine, that removal, as in *Case* 9, is rendered quite impossible. Most difficulty is met with high up under the diaphragm, where it is impossible to do anything except work in the dark. In *Case* 8 the pedicle had first to be divided and the spleen swung right out, in order to deal with a dense area of adhesion beneath the lower ribs.

As a rule, however, the adhesions can be torn down or divided with scissors without much difficulty. The adhesions themselves bleed only moderately; if there is much blood, it generally comes from a tear in the capsule of the spleen, and the only way of stopping this is to go on and turn the spleen out as quickly as possible. When the outer surface and upper pole are free, the rest is fairly easy. The adhesions at the vertebral border behind are never dense, the lower pole can be pulled up and dealt with in the light, and the same is fortunately the case with the more important adhesions to the stomach and other viscera.

Practically, the bleeding from adhesions is not profuse or important. It soon stops when the spleen is removed, and never requires drainage. The difficulty is rather the mechanical one of getting the spleen free. A spleen without adhesions can be removed in half an hour; an adherent one may take over an hour.

When all the adhesions have been dealt with, the lower pole is pulled out of the wound. There is a constant leash of big vessels running down to a sort of secondary hilum near the lower pole, and carrying with them a fold of peritoneum from the pedicle. These vessels are divided between ligatures, and the peritoneum stripped up to the pedicle proper. The spleen is then only attached by the pedicle, and the next step is to bring it outside the abdomen. To do this the assistant pulls out the lower pole, and the operator passes his right hand up between the spleen and the ribs till he can grasp the upper pole in his palm, while with his left hand he depresses the outer lip of the wound. Then, by squeezing, pulling, and pressure, the spleen can be levered gradually out. It is bigger than the incision, but is elastic, slippery, and capable of rotation. It is important to prevent its coming out with too much of a jerk, and once out it must be supported by a dresser to prevent undue strain on the pedicle.

The remaining step is to ligature and divide the pedicle, and this, to judge from the reported cases of death from hæmorrhage, is the crux of the operation.

The difficulty is that the vessels are large, with thin walls, and since the spleen is an elastic bag full of blood under pressure, they are ready to bleed furiously from either end or both. Bleeding from the splenic end is no loss to the patient after the artery has been tied, but it is messy and demoralizing, for in a very big spleen it may amount to about a quart (*see* p. 431). To avoid this, it is necessary to secure both ends of the divided vessels. For this purpose forceps are unsatisfactory; they retract into a dark cavity after division of the vessels, and it is difficult to pull them up for ligature afterwards without putting undue strain on thin vessels lying in loose connective tissue. Moreover, they are very much in the way, especially as they have to be big in order to clip securely large vessels like the splenic vein.

Many good surgeons use big clamps which grasp the whole pedicle, and apply ligatures to the individual vessels either proximal or distal to these. I have tried this method and do not like it. It gives apparent security, but the clamp is very much in the way on a short pedicle, and flattens out the tissues so that it is harder to tie the vessels securely.

For the reasons given above, double ligature is advisable, and a clamp makes this much more difficult of application.

The method which Dr. Aly Bey and I have found the best, is to isolate the vessels successively and divide them between ligatures. Two pairs of forceps are first applied to the upper and lower edges of the central end of the pedicle respectively, so as to enable it to be pulled up readily for inspection afterwards.

The mass is then dissected, chiefly with closed forceps and gauze, with a little help from the knife. It consists of connective tissue and fat, with occasionally lymphatic glands or the tail end of the pancreas, and often some splenculi. The smaller vessels running to the stomach lie in front; the splenic artery, as a white tortuous trunk, lies deeply near the upper border, and the mass of the central part consists of veins joining to form the splenic vein.

As each vessel or small cluster of vessels is isolated, it is cleared for an inch or more, and a loop of stout silk passed under it. The loop is cut, and the resulting two ligatures are pulled in opposite directions and tied as far apart as possible. The vessels included are then cut nearer the splenic end, so as to leave a longer stump centrally.

In this way, with about half a dozen ligatures or less, all the main vessels are tied separately. The spleen is then taken away. The stump is pulled up by the forceps for inspection; it consists of a long narrow strip of raw surface, chiefly fat, with the ends of the vessels lying at intervals along it. If broad, it can be overrun with a fine continuous suture of catgut, care being taken not to prick the vessels, while any opening into the lesser sac is closed in the same way.

Pedicles differ in density, and it is sometimes impossible to get the vessels quite clean. Usually it is easy enough; but if not, the pedicle must be tied in as many small parcels as possible.

This method seems to me neater, safer, and more surgical than any which draws the whole pedicle up into a bunch, and leaves a dead stump distal to the ligatures. It also minimizes bleeding, and I have seen Dr. Aly Bey remove a large non-adherent spleen with a loss, exclusive of abdominal incision, of about two teaspoonfuls. The spleens thus removed are full of blood under pressure. The cavity left is then swept clear of clots if any have formed from the oozing of adhesions, and closed without drainage.

Shock is usually slight, if no blood has been lost, and recovery rapid. A number of detailed accounts of operations will be found in my previous paper,[8] and are fairly typical of the rest; there is therefore no need to add to their number.

The Spleens Removed.—The spleens ranged in weight from 2780 grams (over 6 lb.) to 535 grams (a little over 1 lb.), with an average weight of 1350 grams (3 lb.). The normal weight of the spleen is 170 grams, and consequently the largest spleen was sixteen times the normal weight, the smallest more than three times, and the average eight times.

These weights were taken immediately after removal. The spleens removed by the method described above were nearly all full of blood under pressure, and when the vessels were opened after removal, they discharged blood up to the amount of some 40 per cent of the total weight in the course of a few minutes. With a view to saving some of this blood, I once tried ligaturing the splenic artery at the beginning of the operation, but the loss in this case was also just over 40 per cent. After all, the blood in the rest of the body is not diminished by removing any organ with its contained blood, so the point is not very important.

In appearance, these spleens had the normal shape, with patches of fibrous thickening in the capsule, and the remains of adhesions. Their structure is shown in *Figs.* 269, 270.

After-treatment.—This is the same as in any abdominal operation. It is an advantage to keep the patient propped up.

SERIES OF TWENTY-FOUR CASES, IN TWENTY-TWO OF WHICH SPLENECTOMY WAS PERFORMED.

Case	Sex	Age	Date of Operation	Notes	Operator	Weight of Spleen	Results
1	F	15	Aug. 22 1910	Ill two years	O. R.		Operation not completed owing to heart failure. Recovery. Death at home 6 months later (*Fig.* 273)
2	M	12	March 6 1911	Ill three years	O. R.	2040 gr. (4½ lb.)	Recovery: pneumonia: well 11 months later. Rise of R.B.C. from 1,808,000 to 3,680,000
3	M	22	April 4 1911	Bad bilharzia	O. R.	1130 gr.	Recovery: died at home 5 months later. Cause unknown
4	F	25	May 9 1911	Bronchitic	O. R.	1340 gr.	Acute bronchitis; recovery; shown in good health 2 years later (*Fig.* 274)
5	M	25	May 30 1911	Unable to work three years	O. R.	1810 gr.	Recovery: 5 months later had gained 23 lb. and was doing full work. Seen again well, after 2½ years
6	M	18	July 25 1911	Ill four years	A. B.	1340 gr.	Recovery: 5 months later was doing half work. Seen again well, after 1¾ years, in good condition (*Fig.* 275)
7	M	20	Sept. 5 1911	Ascites tapped, seven litres	O. R.	Not noted	Died comatose third day. Œdema of brain. No abdominal hæmorrhage or peritonitis
8	M	14	Nov. 7 1911	Ill two years	O. R.	1250 gr.	Died of acute dilatation of the stomach (*Fig.* 272)
9	M	50	Aug. 3 1911	—	A. B.	—	Operation abandoned owing to density of adhesions
10	M	16	Feb. 27 1912	Ill seven years	A. B.	2200 gr.	Recovery. Acute bronchitis; discharged well in 3 weeks. Cannot be traced (*Fig.* 276)
11	M	15	March 19 1912	Jaundice. Ascites tapped, six litres	O. R.	2780 gr. (6 lb.)	Death on the 18th day from portal thrombosis (*Fig.* 271)
12	M	28	April 4 1912	Pain after food four months	O. R.	1585 gr.	Recovery. Erysipelas. Not traced
13	M	7	May 21 1912	Ill all his life, emaciated, 3st 8	A. B.	1675 gr.	Recovery. Not traced
14	M	16	July 2 1912	Ill two years	A. B.		Recovery. Well 9 months later
15	M	12	July 23 1912	Treated two years, 606 etc.	O. R.	950 gr.	Recovery. Well 9 months later
16	M	20	Aug. 27 1912		O. R.	1200 gr.	Died. Extensive bilharziasis, bilharzial cirrhosis
17	M	15	May 13 1913	Two years fever etc.	O. R.	855 gr.	Recovery
18	M	15	May 18 1913	Ill over one year	O. R.	725 gr.	Recovery
19	M	30	May 22 1913	Ill over one year	O. R.	2258 gr. (5 lb.)	Recovery
20	F	15	June 5 1913	Splenomegaly over two years. Pain after food	O. R.	1528 gr.	Recovery. Well after 4 months and earning full wages
21	M	30	June 17 1913	Bronchitis	O. R.	983 gr.	Recovery
22	F	14	June 26 1913	Ill three years	O. R.	965 gr.	Recovery. Broncho-pneumonia
23	M	14	Aug. 5 1913	Pain one year	A. B.	535 gr.	Recovery
24	M	30	Oct. 21 1913	Ill five or six years	O. R.	1200 gr.	Recovery

Complications.—The only complication of any frequency is bronchitis or pneumonia, which occurred in five cases. This might be attributed to paralysis of the vault of the diaphragm if it always occurred on the left side, but it does not. Probably the fact is that the patients have, before operation, some trouble in the lung due to abdominal distention, and the exposure and shock of the operation lights it up. It has never proved fatal, but easily might have. The effect on the leucocyte count is to send it up very rapidly. The rarer complications are noted under the fatal cases.

CONCLUSIONS.

1. A disease exists in Egypt, of which the essential features are progressive cirrhosis of the liver, enlargement of the spleen, and anæmia.

2. This disease closely resembles that described in the literature as Banti's disease, but it is associated with fever, is probably due to an infection, and the hepatic cirrhosis, instead of being a terminal stage of a "splenic anæmia," is an essential part of the disease from its commencement.

3. Slight cases may recover; more severe cases end in death from hepatic cirrhosis with ascites and emaciation.

4. Cases which have progressed to the stage of ascites are unfit for operation; they usually die in about six months.

5. Severe cases which have not yet reached the stage of ascites may be much benefited, and sometimes cured, by removal of the spleen.

6. The mortality of this operation in such cases is about 10 per cent.

7. The chief operative risk is hæmorrhage, and this may be best met by a systematic division of individual vessels between ligatures.

REFERENCES.

[1] ARMSTRONG, Splenectomy and Banti's disease, *Brit. Med. Jour.*, 1906, ii, 1273.
[2] TORRANCE, Splenectomy in Banti's disease, *Ann. Surg.* 1908, i, 41.
[3] JOHNSTON, Splenectomy, *Ann. Surg.*, 1908, ii, 50.
[4] MAYO, Surgery of the Spleen, *Jour. Surg. Gyn. and Obst.*, 1913, 233.
[5] WILSON, The Pathology of Splenomegaly, *Ibid.*, 240.
[6] GIFFIN, Clinical Observations concerning twenty-seven Cases of Splenectomy, *Amer. Jour. Med. Sci.*, 1913, No. 6, 781.
[7] DAY AND FERGUSON. An Account of a Form of Splenomegaly with Cirrhosis, Endemic in Egypt, *Ann. Trop. Med. and Parasit.*, 1909, Nov. No. 3.
[8] RICHARDS AND DAY, Egyptian Splenomegaly and its Surgical Treatment, *Trans. Soc. Trop. Med. and Hygiene*, 1912, No. 8, 333.
[9] FERGUSON, The Lesions of Bilharzial Disease, *Glasg. Med. Jour.*, 1913, Jan.

Some other Papers of interest:—

BLAND-SUTTON, Observations on the Surgery of the Spleen, *Brit. Jour. Surg.*, 1913, Oct.
SUTHERLAND AND BURGHARD, The Treatment of Splenic Anæmia by Splenectomy, *Lancet*, 1910, ii, 1819.
OSLER, ROLLESTON, etc., Discussion on Splenic Enlargements other than Leukæmic, *Brit. Med. Jour.*, 1908, ii, 1131.
SUMMERS, Splenectomy in Banti's disease, *Ann. Surg.*, 1908, i, 1006.
CLIFFORD ALLBUT, *System of Medicine*, v, 777 *et passim*.

A CASE OF ENDOTHELIOMA OF THE ULNA REPLACED BY A TIBIAL BONE-GRAFT.

By GEORGE SCOTT WILLIAMSON, Bristol.

The following case is remarkable on account of the rare nature of the tumour occurring as an osseous growth, and also because of the remarkably good results attained by an autoplastic graft.

Clifford S. School-boy, aged 9 years.

History.—In June, 1911, a nævus was first noticed on the vertex of the scalp. As it was enlarging and somewhat irritable, it was excised by his doctor. In August, 1911, he was sent to the General Hospital, under Mr. Hey Groves, with a small elastic tumour about one inch in diameter in the site of the scar. This was removed with an ample margin of healthy skin. In January, 1912, he was re-admitted to the hospital with glandular swellings on both sides of the neck and a fusiform enlargement of the shaft of the right ulna. The tumour removed from the scalp had been proved microscopically to be a typical endothelioma. On February 10, 1912, the glands were removed from both sides of the neck. These showed the same form of growth.

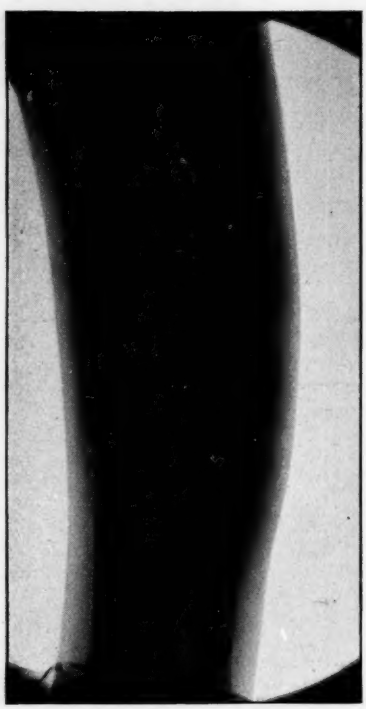


Fig. 277.—Skiagram before Operation.

Operation on Ulna (Feb. 17, 1912).—The tumour of the ulna appeared by the *x*-rays (*Fig.* 277) to be a medullary growth uniformly infiltrating nearly the whole of the diaphysis. Its removal involved the sacrifice of the whole shaft of the bone to within a short distance of the epiphyseal cartilage on each side. Fearing the possibility of a bone-graft not living, and therefore having to be removed, a steel strut was inserted made of two portions slipping over one another like a telescope. One end of this was thrust into each epiphysis, and the two halves fixed at the right length by a screw. A portion of the anterior border of the tibia was next removed in such a way that a strip of periosteum and a piece of medullary tissue were included in the whole length of the bone. The graft, which was about 6 inches long, was laid among the muscles from which the ulna had been removed. The wounds in the arm and leg were each closed by suture of both fascia and skin.

The boy made an uninterrupted recovery, all the wounds healing by first intention. Before he left the hospital, i.e., within three weeks, he could use his arm and hand quite naturally, and the tibial wound never gave rise to any inconvenience.

In June, 1912, his general condition was very satisfactory. The *x*-rays show the graft and steel strut in position (*Fig.* 278). There is distinct evidence of the formation of new bone round the graft and at its upper end. The movements of the arm were perfect. There was some enlargement of the glands of the neck.

FIG. 278.—SKIAGRAM FOUR MONTHS AFTER OPERATION, showing both steel strut and bone-graft in position.

In September, 1912, he was visited at his own home in consultation with Dr. Eglington. He had a large, nodular, elastic tumour on each side of the neck, densely fixed to the deep structures, and causing great difficulty in swallowing and breathing. The arm was quite satisfactory, and the boy could use it to prop himself up in bed in a sitting posture, all the movements at the elbow and wrist being normal. The graft felt as if it were solidly united to the olecranon, but there was a distinct gap between the lower end of the graft and the lower epiphysis of the ulna.

October, 1912, death. Unfortunately no autopsy, even of a partial character, was permitted.

The specimen removed (*Figs.* 279, 280) consists of practically the whole shaft of the ulna. It is $5\frac{3}{4}$ in. long, of fusiform shape, and 1 in. in diameter at its central portion. The outer surface is covered by intact periosteum, fascia, and the origin of muscles. When cut open it exhibits a coarsely vacuolated appearance, and is of a deep maroon colour. On one side, the shaft of the bone is still intact, but on the other it has been quite replaced by the new growth. The appearance is in fact very similar to that of an ordinary myeloid sarcoma. But the microscopical section shows it to be an endothelioma exactly similar to the scalp tumour originally removed. In this case there is clear evidence of the origin of a malignant endothelioma from a nævus, and an illustration of the fact that such a tumour is in fact a sarcoma showing a liability to form secondary growth in the long bones. As far as it was possible to form an opinion as to the malignancy of the tumour from its microscopical appearance, this tended to show that it was comparatively benign; and it was this very emphatic opinion which encouraged the attempt to remove the secondary growth. Unfortunately, the result proved that our optimism was not justified. But it is noteworthy that no recurrence took place in the arm up to the time of death.

From a surgical point of view there are several comments suggested. In the first place, the ready way in which the large bone-graft healed in its place and took on the functions of the ulna was all that could have been desired. The use of the anterior margin of the tibia seems to be by far the best method for

procuring a substitute for the formation of new bone. Owing to its length, the tibia can supply a longer graft than any other bone in the body. It can be approached and removed without disturbing anything but skin and fascia. It consists of a very strong buttress of dense bone, and at the same time a layer of medullary tissue is taken with it, which by its open texture makes new vital connections easy. Its removal in no way interferes with the strength of the leg or the function of the joints.

FIG. 279.—PORTION OF ULNA REMOVED, viewed from outer aspect.

FIG. 280.—PORTION OF ULNA REMOVED AND CUT OPEN, to show the vacuolated new growth.

Histological Notes.—The original tumour is composed of broad interlacing strands of fairly dense fibrous tissue, enclosing spaces of varying size. The spaces are lined by a flat pavement endothelium, and sometimes contain red blood-cells. The general appearance is that of an angioma, though here and there masses of the endothelial cells occur where apparently the endothelium had proliferated and filled the space; from such masses outlying cells can be traced, suggesting a budding process and a probable malignancy. Similarly, within the space papilliform projections with little or no fibrous stroma are to be found.

The glands removed at operation contain aggregations of endothelial cells, and within the gland the original form of tumour has been reproduced as described above. The fibrous stroma is not so dense. *Fig.* 281 shows a nodule of endothelial cells (A), and in the lower half of the picture an attempt at space formation can be noted. *Fig.* 282 shows the nodule (A) of *Fig.* 281 more highly magnified; the form of the cells can be made out.

The ulna was the seat of a diffuse growth (*Fig.* 280) apparently spreading out from the marrow space, and thinning the bone from a direct process of invasion by advancing projections of endothelial tissues. In the bone the angiomatous nature of the growth is well shown, conforming in every respect to

the original growth, except for the scantiness of the fibrous stroma and the large size of the spaces (*Fig.* 283). At (A) a portion of bone is shown surrounded by endothelial cells in a loose stroma, enclosing a space containing red cells; within the mass of red cells the tips of endothelial papillæ are discernible as darker areas. *Fig.* 284 shows a space in which several papillæ are projecting; the nature of the growth and its general form are typical of the original growth.

FIG. 281.—CERVICAL LYMPH GLAND
($\frac{1}{2}$-inch obj. with No. 4 eyepiece).

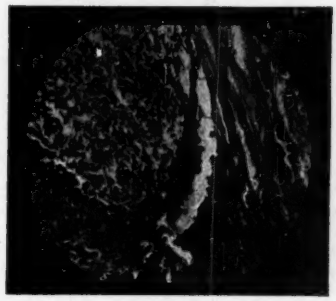


FIG. 282.—The portion A of *Fig.* 281 more highly magnified
($\frac{1}{8}$-inch obj. with No. 4 eyepiece).

FIG. 283.—BONE TUMOUR
($\frac{1}{2}$-inch obj.).

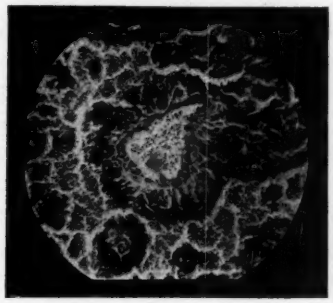


FIG. 284.—BONE TUMOUR
($\frac{1}{8}$-inch obj.).

It is certainly a rare occurrence for a nævus to become converted into a malignant endothelioma; and still rarer for such an endothelioma to form a metastatic growth in the shaft of one of the long bones.

At the time that the excision of the ulna was undertaken, it seemed most probable that the boy had a myeloid sarcoma, and there was nothing sufficiently definite about the malignancy of the original tumour to make it probable that the bone growth had anything to do with it.

It is to be noted that the local malignancy of this type of endothelioma is not very great, inasmuch as neither the primary nor the bone growth recurred after they had been freely removed.

AN EXPERIMENTAL STUDY OF THE OPERATIVE TREATMENT OF FRACTURES.

By ERNEST W. HEY GROVES, Bristol.

During the last twenty years ever-increasing attention has been given by surgeons to the operative treatment of fractures. This has resulted from various causes. Amongst them may be mentioned the Workmen's Compensation legislation, which has directed notice to the unsatisfactory functional results produced by the older methods; the advent of the *x*-rays, showing how very seldom anatomical accuracy of apposition is attained by splint treatment; and the general advance of aseptic surgery, which has made a direct attack upon the broken bones a justifiable undertaking. There has thus come about such a general consensus of opinion that many cases of even simple fracture require an open operation, that it is not necessary to argue this proposition. But there still remain the important questions to be answered: In which case is operative treatment demanded: and In which will the non-operative give a perfectly satisfactory result? It is exceedingly difficult to answer these questions, with any approach to accuracy, from clinical evidence alone. The circumstances of clinical observations vary so enormously, that comparison of the results of different methods of treatment is almost impossible. Some of the more important of these varying factors are: the age and health of the patient; the site and anatomical condition of the fracture; the length of time that has elapsed before treatment was undertaken; the period between the termination of the treatment and the recording of the result; the skill and the attitude of mind of the surgeon in the method employed. It is only by experiment that these variables can be replaced by constants, and a true estimate made of the factors which underlie success or failure of operative methods.

My primary object in taking up this research was to determine the comparative merits of the different methods of operative fixation of fractured bone fragments, as judged by the organic union produced by them. In particular, I wished to ascertain whether the rapidity and firmness of repair were the better promoted by intramedullary pegs or by external plates and screws. But one inquiry has led on to another, and the appearance of Sir William Macewen's epoch-making work upon the growth of bone has given me a fresh stimulus to examine the source and method of formation of callus.

Before describing my own work, a few words are necessary in relation to similar work done by others. In the broad meaning of the term, the experimental study of bone injuries and bone growth in the lower animals is dealt with in a vast body of literature, which it is difficult even to catalogue, and almost impossible to epitomize. The three burning questions of the origin of callus, the role of the periosteum, and the viability of bone-grafts, have dominated this literature to such an extent that scarcely any other topic is mentioned. Havers, in 1692,

whose name has ever since been identified with the vascular canals of the bone, described the periosteum as simply a connective tissue, limiting and vascularizing membrane ; but his work, apart from mere speculation, was purely anatomical and microscopical. A less remembered observer, Antoine de Heyde, in 1684, published the first experimental observations on fractures, having worked with frogs, and having come to the conclusion that callus was formed by calcification of the blood, extravasated round the broken bone ends. It was, however, in the middle of the eighteenth century (1739–1743) that the first systematic work on this subject was carried out by Duhamel, who was the originator of the modern generally accepted theory of the function of the periosteum. In his view the periosteum became thickened and succulent round a fracture, and by pushing this new tissue in amongst the fragments, it formed the callus. He it was who founded the term "cambium layer" of the periosteum which is now in every-day use in German literature. Eighteen years later, Troja produced experimental necrosis, and described the new bone formation between the dead bone and the periosteum. A century after Duhamel, after many less remembered works and discussions on the subject had appeared, came the great work of Ollier (1867), which remains to-day as the foundation of all our exact knowledge of bone growth. Ollier's work was so thorough and careful, that his conclusions have attained an almost unassailable position. He proved the regeneration of bone from periosteum in every possible way, and ever since his day the periosteum has been regarded as the most important vital tissue of the bone. Nearly fifty years have elapsed since Ollier's treatise, and during this period practically the whole of modern surgery has arisen. Very many works have been written dealing with fractures, experimentally produced, but these have chiefly concerned themselves with the structure and origin of callus. More recently, the practical question of filling bone defects by grafts of dead or living bone obtained from various sources has absorbed the attention of workers, who have sought to examine experimentally this method of bone re-construction. The most notable contributions to this part of the subject have been those of Barth (1893) and Axhausen (1898). The former showed that large living bone masses, when transplanted, lost their vitality, and acted in the same way as a piece of dead bone, i.e., as a mere splint or scaffolding on which new bone is laid down. The latter proved that certain areas of transplanted living bone retained their vitality and acted as centres of new bone formation. Every practical worker on the subject has moreover endorsed the opinion that a living bone of the same species gives much quicker, stronger and more certain results than dead bone, or than that taken from another species.

It was in 1911 that Macewen produced a little simple work entitled, "The Growth of Bone," in which he showed, by a few most convincing experiments, that bone growth can and does take place quite independently of the periosteum, and that the periosteum is in no way essential for bone growth. As a deduction from these observations, the author would once more revert to the view of the periosteum taken by Clopton Havers in the middle of the seventeenth century, viz., that it is chiefly a vascular limiting membrane.

But in all the literature of this subject I have been unable to find any detailed account of experimental observations on the operative treatment of fractures. There have been papers by Rossi, Roncali, Potârchâ, whose titles

suggest that they may have a bearing on this aspect of the question, but unfortunately they are not accessible in this country. Bum, Forlini, Bergel, Pochhammer and Schmieden have made experimental observations of the influence of passive congestion or the application of fibrin or blood-clot in the hastening of fracture repair. All the other papers deal with the formation of callus, or the rôle of the periosteum or medulla in experimental fractures. At the end of this article I have given references to all these papers, classified according to their subject matter.

A GENERAL DESCRIPTION OF THE METHODS EMPLOYED AND THE MATERIAL USED.

I began with the idea of using dogs, cats, and rabbits as subjects of my experiments, but was very soon led to modify this plan. The use of dogs is not only expensive, but it involves many unnecessary difficulties when a number of animals have to be kept under observation at the same time; and up to the present I have not employed any of these animals. Nineteen rabbits were used, but the frailty of their bones made them difficult to deal with, and splintering of the shaft is liable to take place. Further, the fact that in the leg bones the fibula of the rabbit is not a separate bone, but only a slender ossicle which is fused with the tibia at its lower end, makes it difficult to fracture the tibia without at the same time breaking the fibula.

The tibia of the cat is in every way most suitable for an extended series of experiments. It is stout and strong, it has a medullary cavity $\frac{1}{8}$ in. to $\frac{5}{32}$ in. in diameter, and can be drilled in various directions without breaking. The fibula, moreover, is a separate bone, which, whilst allowing free manipulation of the tibia, nevertheless serves as a splint in helping to maintain the tibial fragments in position. Of my 100 experiments, 81 have been on cats, and 19 on rabbits; 65 on the tibia and 35 on the femur.

As regards the operative technique, it may be well to describe here the general plan which has been followed, reserving the description of special methods until later.

The animals were anæsthetized by a laboratory attendant with open ether, and then tied to a warm table by the four paws. The thigh or leg was shaved after washing with etherial soap, bathed with spirit and ether, and after drying, painted with 10 per cent iodine solution. A towel with a median slit was placed over the animal, and the edges of the slit secured to the area of operation by a few stitches. No lotions were used, the swabs were all dry, and the general technique was exactly as in an ordinary surgical operation, including, of course, the use of dry-sterilized gowns and gloves. The majority of the actual operations were carried out single-handed, though occasionally a retractor was held by an assistant through the towel. It was very seldom necessary to ligature a vessel. Drainage of the wound was never done, the fascia and skin being closed separately by fine continuous catgut stitches. The wound was dressed by a small fragment of gauze smeared with 10 per cent iodine in collodion. About a week after the operation this gauze came away, and the wound required no further attention. No attempt was made to fix the limb in any way after the operation, the animal being simply placed in a roomy cage upon clean hay.

The conditions of my licence required me in every case to divide the bone by a saw or forceps through an incision in the soft parts. This was done in most cases by a fine fret-saw, making an incision as nearly as possible at 45° to the long axis of the bone.

Fixation by Short Plates and Screws.—In modern surgical practice, the method of fixing fractures which has become most popular is that of "plating." A short steel plate is used, and this is screwed on to the outside of the bone by short screws which hold the dense bone, but do not penetrate the medullary cavity. I endeavoured to carry out this principle in animals, but without any success.

The plates used were $\frac{3}{4}$ in. long, $\frac{1}{8}$ in. wide, with two holes at either end. The screws were $\frac{3}{16}$ in. long. In order to ensure a good position of the bone, the holes were drilled, then the saw-cut made part way through the bone, the plates were screwed into position, and the division of the bone was completed. In this way a firm fixation was always made in a perfectly good position. But in all nine experiments—two cats (tibias), two rabbits (tibias), five rabbits (femurs),—the bone-ends became disunited within the first week, with more or less angulation and deformity. This was due in every case to the screws coming out. Usually both screws came out from one fragment and the plate remained firmly fixed to the other; but sometimes all the screws were out and the plate was loose among the muscles.

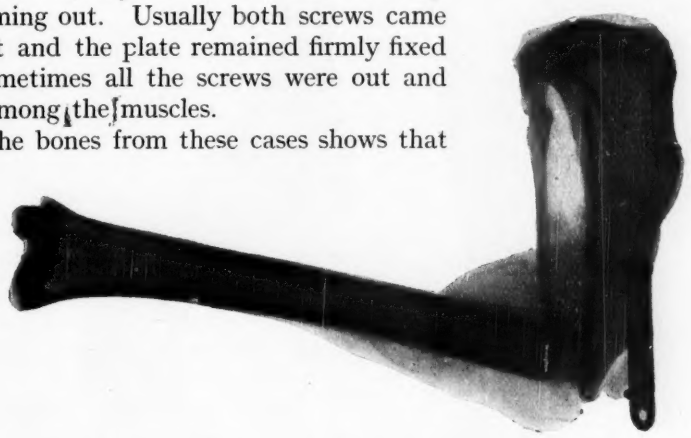


FIG. 285.—Skiagram of rabbit's tibia, 21 days after plating. Screws have come out of the lower fragment, and the plate protruded from the wound.

Examination of the bones from these cases shows that the screw-holes become enlarged, so that whereas the screws hold tightly at the time, later the same sized screw will drop loosely into the hole. The whole muscular force of the leg acts upon the grip between the screw-thread and the bone, and the latter quickly gives way by a process of absorption.

A second undesirable feature of this series of experiments was the tendency to sepsis, with occasional extrusion of the plate. In three cases there was a septic discharge from the wound, and in a fourth, though the wound was healed, there was periostitis, and a large abscess cavity among the muscles. This marked tendency to sepsis as compared with other methods, is due to the combination of a great irritation caused by free movement of the displaced fragments, with the presence of a foreign body. That it is not due to faulty technique is shown by the fact that in other methods where the same procedure was observed, there was very little sepsis. That it is not due simply to the presence of foreign bodies is evident by the fact that,

in the next series, where very much larger plates and pins were used, it did not occur once.

Thus two facts are demonstrated clearly: (1) That short plates and screws, in the absence of external splint fixation, rapidly become loose; (2) That when the fixing agents are once loose amidst the displaced fragments, sepsis is very likely to be set up.

Of course the circumstances of these experiments are not the same as in human surgery. The size of the bones is such that very small screws have to be used. The co-operation of the human patient with the use of external splints, will make the loosening of the plate much less likely. But if the application of splints is necessary after the plating of a fracture, this method will be liable to some of those very evils of the splint treatment which the operation is intended to avoid; that is to say, the muscles and joints will suffer from long immobilization. Moreover, in spite of the use of splints, it will often be found in human surgery that the plates and screws do become loosened. This may be demonstrated by the *x*-rays, and is proved by those frequent cases where, weeks after the healing of the wound, a sinus is formed, leading down to loose plates and screws.

FIG. 286.—Skiagram of rabbit's femur (No. 26), 21 days after plating. Screws have come out from lower end. Mal-union.

FIG. 287. — Rabbit's femur (No. 28), 31 days after plating. The screws have come out from the upper fragment. Note the quantity and density of the callus.

The general pathological features of this series may best be described by a few skiagrams and drawings.

Fig. 285 is a skiagram from a rabbit's tibia (No. 23), twenty-one days after operation. The plate remains firmly fixed by the upper screws. There is marked angular deformity.

Fig. 286 is a skiagram of a rabbit's femur (No. 26), also twenty-one days after operation. There is marked overlapping of the fragments, and the screws have both come out from the lower fragment and are lying loose in the soft tissues. Healing was aseptic.

Fig. 287 (No. 28) is a rabbit's femur, thirty-one days after operation.

The screws have become displaced from the upper fragment, and the bone is united with marked angular deformity by callus, which is exceptionally dense for this period. Healing was aseptic.

Fig. 288 (No. 32) is from the tibia of a cat, nineteen days after operation. The screws have come out from the upper fragment and have been discharged from the wound, which has become septic.

FIG. 288.—Cat's tibia, 19 days after plating. Screws have come out from upper fragment, and have been discharged through the wound.

It may be noted that in these four examples, both the tibial cases became septic. This is not due to any difference of technique, and in fact the tibia is much easier to plate than the femur. I believe that the sepsis is the result, and not the cause, of the loosening of the screws. It is evident from this series that the screws do rapidly become loose in all cases under the given conditions. Directly a little movement is possible between the screw and the bone, and between the bone ends, there is a great outpouring of tissue secretion, both fluid and cellular. If the source of irritation and the fluid collection lies just under the skin, the wound will probably be opened by the mere tension of the fluid, or by the direct pressure of the plates and screws (e.g., see *Fig.* 285). Once the wound is open for the fluid discharge, septic infection of the whole area is inevitable. This point is of great importance, and I shall refer to it again later.

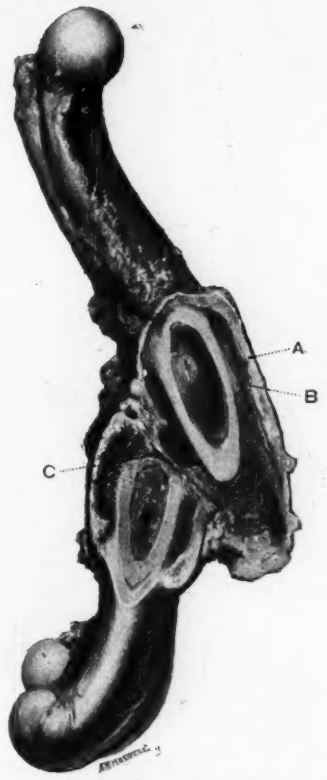


FIG. 289.—Rabbit's femur (No 25), 42 days after plating. Malunion with great angulation. A section has been made through the line of junction to show the structure of the callus.

A, Peripheral cartilaginous callus. **B**, Ossified callus next to the bone. **C**. Line of fracture where callus is still cartilaginous.

Fig. 289 is a drawing of a rabbit's femur (No. 25), forty-two days after operation, the wound of which had healed without sepsis. The plate fixation had given way very soon after the operation. It shows the great callus excess usually produced in conditions in which the raw bone ends have much mobility; that is to say, conditions of

mechanical irritation. Each broken fragment is covered in by an exuberant callus mass, which has ossified next to the bone, but peripherally remains cartilaginous. The line of fracture is still distinct.

Fig. 290 is a drawing from the same case as *Fig.* 286, i.e., a rabbit's femur twenty-one days after operation (No. 26). It shows, as in the last specimen, the lateral union of the fragments by the callus excess, the plate still being firmly screwed to the upper portion, but the screws having come out from the lower.

FIG. 290.—Rabbit's femur (No. 26), 21 days after plating. Screws have come out from the lower fragment. Mal-union with lateral displacement.

Fig. 291 is a drawing from the same case as *Fig.* 287, i.e., a rabbit's femur thirty-one days after operation (No. 28). It presents the same callus excess as the last two cases, and the same arrangement of ossified and cartilaginous areas, the cartilage remaining chiefly at the periphery and at the line of fracture.

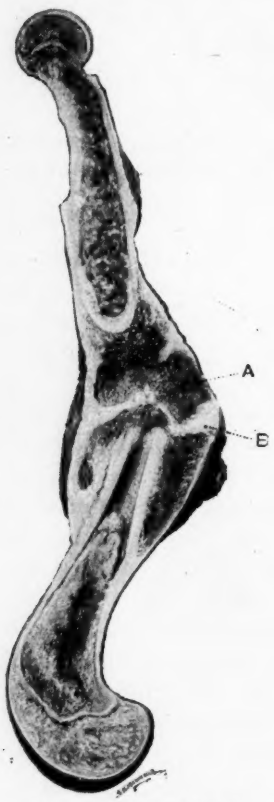


FIG. 291.—Rabbit's femur (No. 28), 31 days after plating, cut down the centre to show union.
A, Ossified callus. B, Callus which is still cartilaginous at the line of fracture.

The next two specimens show the formation of a false joint. It is most difficult to say exactly what circumstance determines in any given case, whether a mal-united fracture will heal by callus excess, or whether non-union with a false joint will occur. The pathological factor is clearly whether much active callus is formed, or whether there is merely fibrous union, allowing free play of the bone ends; but the conditions which determine whether much or little callus is laid down may be various. Three such circumstances are, the degree of mobility, the interposition of soft parts, and the tendency of the bone to callus formation as influenced by blood-supply or the age of the bone. In the cases now under consideration, the only constant difference between those in which there is mal-union with callus excess, and those in which a

false joint occurs, was the age of the animals, as judged by the junction of the epiphyses. The young bones, in which the epiphyses have not yet joined, all formed callus excess; but the older ones, whose natural growth had ceased, formed false joints.

Fig. 292 is a rabbit's tibia (No. 24), thirty-three days after the operation. Healing was aseptic. The bone ends are widely separated, and lie in a large cavity which was partly filled with fluid and partly with fibrin. The soft tissues are matted together to form a strong fibrous capsule. Both bone ends are bare and their edges rounded, whilst the screw-holes are enlarged and smoothed away, the plate and all four screws lying loose in the cavity of the joint. The *x*-rays show that both epiphyses have fused with the shaft.

FIG. 292.—Rabbit's tibia (No. 24), 33 days after plating. All the screws have come out. There is an early stage in the formation of a false joint. The ends of the bone are becoming rounded off. The screw-holes are enlarged and their edges rounded.

FIG. 293.—Rabbit's femur (No. 27), 38 days after plating. There is a perfect false joint, of which the upper fragment forms the ball and the lower the socket.

Fig. 293 is from a rabbit's femur (No. 27), thirty-eight days after operation. Healing had been aseptic. A very perfect new joint is seen between the fragments. The lower end of the upper portion of bone is smooth, rounded, and covered by fibro-cartilage, and it rests in a socket on the front and outer side of the lower fragment, this socket being made up by the saucer-like edge of callus to which the fibrous capsule of the joint is attached. It will be noted that here there is no callus excess, and the epiphyses are fused to the shaft.

Table I.—Results of Nine Experiments with Short Plates and Screws.

No.	Date	Animal and Bone	Period Days	Repair	Anatomical Result	Remarks
23	17/5/11	R. T.	21	Large mass of callus. Lower screws out. Upper screws firm	Great angulation	Plate protruded from wound
24	17/5/11	R. T.	33	All screws out; screw holes enlarged and rounded. Some necrosis of both ends. False joint	Angulation and overlapping	
25	17/5/11	R. F.	42	Firm callus union. Upper screws out	Angular displacement and overlapping	
26	17/5/11	R. F.	21	Callus union. Screws out from lower end	As above	
27	19/5/11	R. F.	38	All screws out. False joint	Angulation and over-riding	
28	19/5/11	R. F.	31	Upper screws out. Firm callus union	Overlapping and angular displacement	
31	19/5/11	C. T.	7	None, fibula fractured. Screws out from upper fragment	Good position	Sepsis
32	7/6/11	C. T.	19	Upper screws out. Early callus union. Necrosis of upper end	Angular overlapping and displacement	Sepsis
36	9/6/11	R. F.	37	Wires broken; plates loose. Large abscess cavity. Periostitis	Great deformity	Wound healed soundly, two plates and perforating wires

Summary.—Under conditions employed the method was quite useless. In every case the screws came out from one or both fragments. In four out of nine, sepsis complicated matters. In three of these, the plates lay just beneath the skin. Plates used were $\frac{3}{4}$ in. long. Screws were $\frac{3}{16}$ in. and $\frac{1}{3\frac{1}{2}}$ in., with metal thread.

Long Plates and Perforating Pins.—It was quite evident that the short plates held in place by short screws which only penetrated one side of the dense bone, were (apart from splints) quite unable to retain bones in position. I therefore tried some much longer and thicker plates, and fixed these in position by pins, technically known as " cotter " or " split " pins, which perforated the entire thickness of the broken shaft. In one case the plate used was 2 in. long and $\frac{1}{16}$ in. thick, but in the other it was only $1\frac{1}{2}$ in. long and $\frac{1}{3\frac{1}{2}}$ in. thick. They were not flat, but in cross-section formed one quarter of a circle $\frac{5}{16}$ in. in diameter. The pins were $\frac{1}{16}$ in. thick, and after being thrust through the plate and the bone, the split ends were turned back, so as to keep the pin and plate in position.

It was only necessary to do a few of these experiments, all of which were on tibias of cats, because the method was uniformly successful. In none was there any sepsis, the wound healed by first intention, and the animals used the leg freely during and after the second week. The periods of observation varied from four to six weeks. In three of these experiments the healing of the bone was quite ideal. The callus was of the minimum amount, and true bony union was evident from the fourth week onwards.

Figs 294 and 295 show four of these specimens, by the *x*-rays and after dissection.

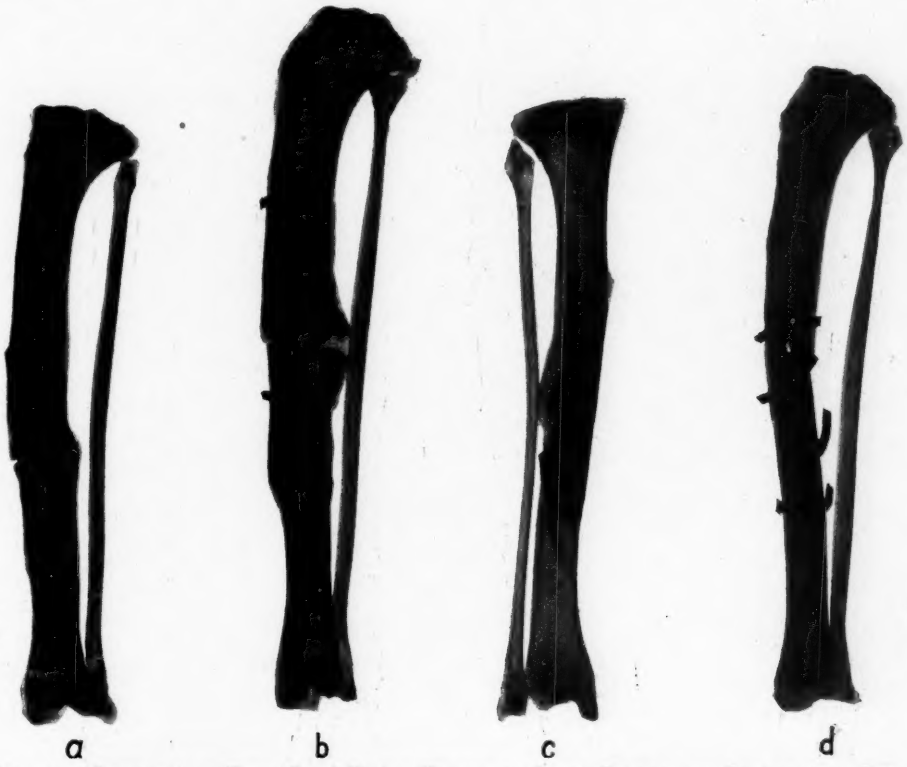


FIG. 294.—SKIAGRAM OF FOUR CATS' TIBIAS UNITED BY LONG PLATES AND PERFORATING PINS.
(*a*). No. 54, 28 days after operation. (*b*). No. 48, 34 days after operation. (*c*). No. 53, 42 days after operation. (*d*). No. 52, 42 days after operation.

(*a*) Is No. 54, twenty-eight days after operation. The seat of union is already firm bone, and the medullary cavity is filled with dense internal callus. Of external callus there is only a thin layer, which partly covers in the plate.

(*b*) Is from No. 48, thirty-four days after operation. This was the specimen in which the longer (2 in.) plate was used. Here, although with a longer plate immobility must have been more assured than in the others, there is some callus excess, the line of bone union is not complete, and there is a wide area of cartilage in the callus mass.

(*c*) Is No. 53, forty-two days after operation, and in *Fig.* 295 the specimen is shown cut down the centre. Complete and perfect union has taken

place, with very little external callus. Internal callus is firm, and the dense bone of the shaft is thickened on its medullary aspect, above and below the fracture. The plate has been removed, and there is perfect solid continuity of the two halves of the bone.

(*d*) Is from No. 52, forty-two days after operation, and it affords a rather startling contrast to the other members of this series. Although, as regards

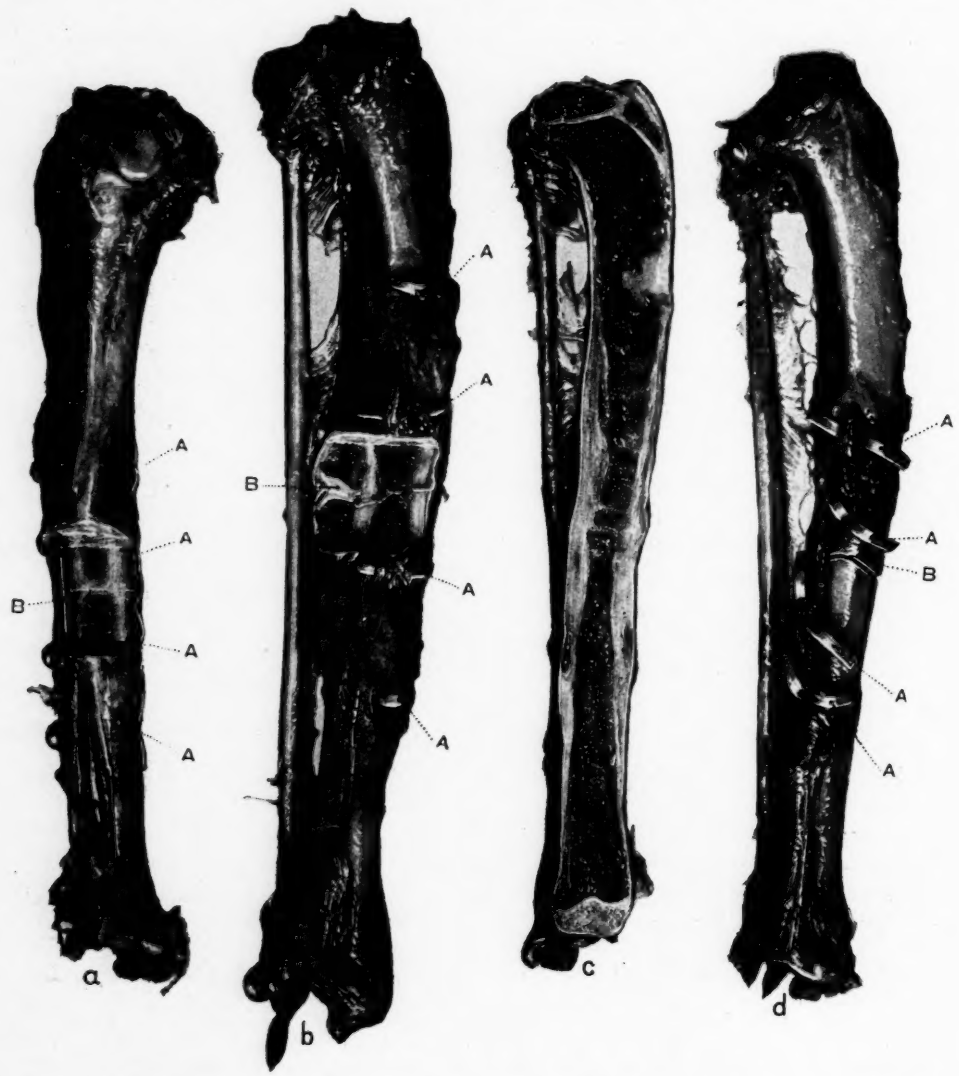


FIG. 295.—FOUR CATS' TIBIAS UNITED BY LONG PLATES AND SPLIT PINS. (*The same as Fig.* 294.)

(*a*). No. 54, 28 days after operation. A piece of bone has been cut out to show the union. **A**, Ends of split pins turned over. **B**, Edge of the plate.

(*b*). No. 48, 34 days after operation, a piece having been cut out to show union. **A**, Ends of split pins. **B**, Wedge-shaped cartilage in the callus at the line of fracture.

(*c*). No. 53, 42 days after operation, cut down the centre, after removal of the plate and pins. There is perfect union. No external callus, visible as such, a short plug of internal callus and a notable thickening of the dense bone of the shaft some distance above and below the fracture.

(*d*). No. 52, 42 days after operation. No callus, no union. **A**, Ends of the pins. **B**, the line of fracture, the edges of which are quite sharp-cut.

function, this animal had been just as well as the others, the wound having healed by first intention and the limb being used freely, yet, nevertheless, the specimen shows a complete absence of callus or any repair, the ends of the bone having undergone an aseptic necrosis up to the nearest pin on each side. The animal was young, and the epiphyses were still separate from the shaft. The only circumstance that appears to be different in the condition of the operation between this and the three other similar experiments, is the fact that the ends of the pins have been left rather long and have been turned transversely, so as partly to surround the bone. This is shown best in the skiagram (*Fig.* 294, *d*). The effect must have been to keep the periosteum and soft parts at a distance from the bone, thus hindering the vascularization of the cut ends.

The importance of this exceptional result is great, in view of the fact that in human surgery many observations have been made that the operative treatment of fractures is accompained by a much-delayed bone repair. It has been customary to attribute this to an immobility which has deprived the bone of the usual stimulus of friction and movement. The present experimental evidence does not support this, because it has been shown that in all the other cases rapid and perfect bone union has occurred when the fragments have been absolutely fixed.

It has been assumed that bone tissue must either be living, with full vitality and reproductive activity, or else necrosed and cast off as a sequestrum. But it seems certain from many observations, that bone may be in an intermediate state, in which circulation and tissue change come to a standstill for the time being, to be re-activated at a later date. Such is the condition of things when a large piece of bone is transplanted from one situation to another. The greater number of its cells die, but later on it is penetrated by other bone-cells and takes on the appearance of new growth. There has been much discussion as to the nature of the bone in this intermediate state. Some say frankly that the bone is dead; but this seems unreasonable in view of the fact that within a short time it is certainly alive and growing. Others say that it merely forms the scaffolding tissue into which cells penetrate and build up new bone. But whatever may be the nature of this latent period, it would seem that it is this period through which the ends of the broken bones pass in these exceptional cases, when treated by operative methods. Aseptic necrosis, or suspended vitality of an injured bone, may be caused by any manipulation, and it usually affects the ends of the broken fragments, being determined most probably by an interference with the blood-supply. It will naturally cause a very great delay in the union of a fracture.

If the method of operative fixation is one which lasts but a short time, e.g. by plates and screws, the fracture will become displaced long before union occurs. On the other hand, if the fixation is of a more permanent character, the delay in the vital action of the bone tissue is of no great matter, because the limb can be used for its full functional activity whilst the delayed repair is going on. One fact, however, stands out clearly in comparing these two methods of plate-fixation; the mere size of the plate has nothing at all to do with its liability to set up inflammation, which may cause its extrusion. A large plate firmly fixed will remain in place indefinitely, whilst a small plate which becomes loose, will set up irritation which leads to its being thrown off. Firmness of fixture is the dominant

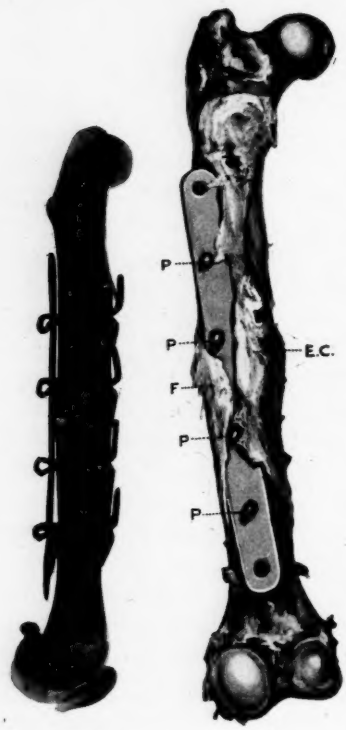


FIG. 296. FIG. 297.

FIG. 296.—Skiagram of a cat's femur (No. 92), 53 days after fixation by double plates and split pins.

FIG. 297.—Drawing of the same femur as Fig 296. P, Heads of pins. F, Site of fracture. E.C, External callus growing over plate.

factor which determines most often whether a plate will remain in position, or become loose.

Nickel-plated steel has no irritating effect upon the tissues; but if a plate is attached to a bone in such a way that slight but constantly recurring movement is permitted, it will cause mechanical irritation, bone absorption, fluid collection, sinus formation, and finally, sepsis. It will be a mere chance in the latter case whether the plates have done any good at all. If they have held the bone in position until union has occurred, their ultimate removal may be a matter of comparative indifference; but if, as is so often the case, they give way before bone repair has taken place, they are worse than useless, because they hinder repair and often bring about sepsis.

An experiment (No. 92), done at a much later date, may be placed with the foregoing. It is illustrated in *Figs.* 296 and 297. A cat's femur was fixed between two flat plates, and the latter joined together by means of four split pins, which perforated the whole thickness of the bone. The skiagram gives a good representation of the arrangement. Healing was good and function perfect, and the animal was killed fifty-three days later. In the drawing (*Fig.* 297) is seen how the external callus is growing over and enclosing the plates.

Table II.—RESULTS OF OPERATIONS WITH LONG PLATES AND SPLIT PINS.

No.	DATE	ANIMAL AND BONE	PERIOD DAYS	REPAIR	ANATOMICAL RESULT	REMARKS
48	22/2/12	C. T.	34	Firm. Callus in some excess growing over the plate. Cartilage at the site of fracture	Good	Good function. Plate was 2 in. long and $\frac{1}{16}$ in. thick
52	2/5/12	C. T.	42	No union. Very little callus	Good	Good function. Plate $1\frac{1}{2}$ in. long $\frac{1}{16}$ in. thick
53	2/5/12	C. T.	42	Firm bony union. Minimum of callus	Good	Good function. Plate as in last
54	16/5/12	C. T.	28	Firm bone union. Small amount of callus	Good	Good function. Plate as in last
92	11/9/13	C. F.	53	Firm bone union	Good	Good function. Double plates

SUMMARY.—In all cases the four holes for the pins were bored in the bone before it was divided. This accounts for the uniformly good result anatomically. The pins were ordinary split or cotter pins, $\frac{1}{16}$ in. in diameter, passed through the whole thickness of the bone and the ends turned back and cut short. The plate, which was nickel-plated steel, formed one quarter of a circle $\frac{5}{16}$ in. in diameter. In every case functional and anatomical perfection was gained. In an actual fracture there would be the important factors of accurate adjustment and the ultimate fate of the plate to be considered. Note the remarkable contrast between 52 and 53 as regards union. In the last case, 92, double flat plates were used.

Outside Metal Collars.—In this group are included seven experiments, all of them being on the cat's tibia. In four, the material used was aluminium plate; in one, steel plate; in one, magnesium plate; in one, aluminium-bronze wire. When metal plates were used they were cut out of thin sheet, wrapped round the bone fragments, and then secured by wire. As far as possible the periosteum was raised from the bone, and the plate secured between the two structures. In three of the experiments the fixation was insecure, and one end of the bone became dislodged from the embrace of the metal collar. There are therefore only four for consideration. In all of these the same course of events is seen, although in different stages.

Mechanically, the collar is a good method of fixation, and the position and function of the limb appear to be quite normal; but the process of repair is delayed and weak even after a long period. At first sight it seems as though the ends of the bone grasped by the collar had undergone necrosis, but closer examination shows that this is not so.

When the collar is removed, the underlying bone is "bare," in the sense that it has no soft tissue covering it; but in the early stages it is rough and pitted, from the exudation of the granulation tissue that is to form the external callus, although the periosteum is quite excluded.

Fig. 298 *a* is a cat's tibia (No. 10, ten days). There is almost no naked-eye evidence of repair, but no necrosis. The surface of the ends of the bone is roughened by very early granulation (callus) formation. *Fig.* 298 *b* is from No. 14 (twenty-five days). There is well-marked callus formation, chiefly present beneath the plate, between it and the bone. Also there are both internal and intermediate callus, but these for the most part are not derived from, or attached to, the actual ends of the fragments, which appear in part to be bare, in a state of necrosis or suspended vitality. The vital union, therefore, is incomplete. These two specimens (*Fig.* 298) show well the early stages of external callus formation, derived solely from the bone when the periosteum is excluded.

Fig. 299 is from No. 9 (fifty-two days), and shows a most interesting specimen. The bones have united in good position. The steel plate is covered in by a layer of periosteum. A thin layer of callus lines the deep surface of the periosteum outside the plate, and this is best marked at the two ends, where the periosteum is close to its bony attachment. There is also a distinct thin layer of external callus on the outer surface of the bone beneath the plate. At the site of fracture a feeble repair has taken place, by cartilaginous tissue. The dense part of the shaft of the bone has been almost entirely replaced by an open spongy tissue, there being the thinnest possible shell of compact bone left. It is evident in this case that the closely encircling plate has interfered with callus formation on the outer surface of the bone, and that, as if to make up for

this, the medullary circulation being good, the bone activity in the form of osteoporosis and bone reconstruction has proceeded with unwonted vigour in its interior.

From a practical point of view the method is of doubtful value. It clearly interferes with the chief agent of repair, viz., the external callus. If the collar is put on so rigidly as to act as an efficient immobilizing splint, it prevents the laying down of external callus; if it is put on loosely, so as to allow a callus layer on its interior, it will permit movement, and this often leads to displacement.

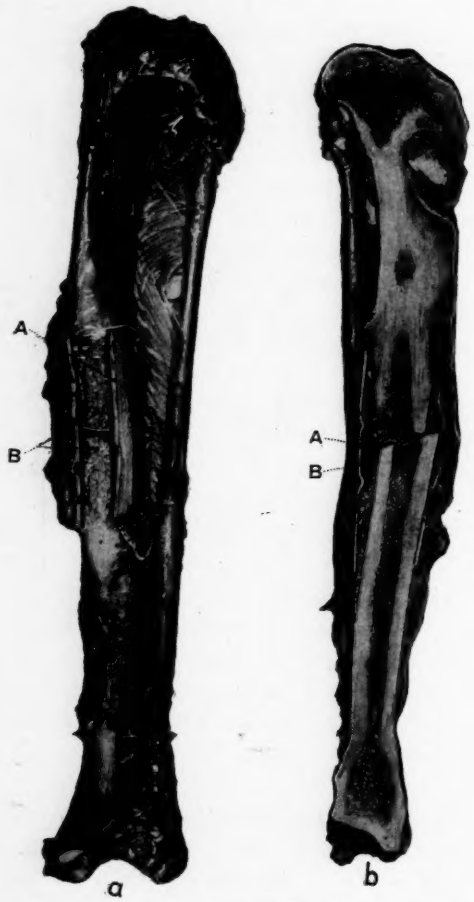


FIG. 298.—TWO CATS' TIBIAS TREATED BY METAL COLLARS.

(*a*). No. 10, 10 days after operation. Aluminium plate, **A**, has been cut open to show bone ends. **B**, The outer surface of these is rough and pitted by the granulations of early callus.
(*b*). No. 14, 25 days after operation. Specimen is cut down the middle, without disturbing the aluminium plate (**A**). There is abundant external callus (**B**) formed beneath the plate, independently of the periosteum.

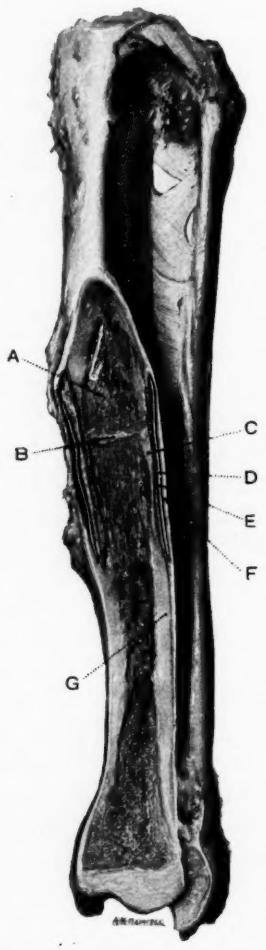


FIG. 299.—Cat's tibia (No. 9), united by steel plate, 52 days after operation. There is very slight external callus, and the deep layer of periosteum is ossified. A remarkable development of internal callus occupies the marrow cavity and the place of the dense bone. **A**, Internal callus. **B**, Cartilage still present at line of fracture. **C**, the much thinned dense bone. **D**, External callus. **E**, Steel plate. **F**, Ossified periosteum. **G**, Thickening of the dense bone below the fracture.

Table III.—Results of Experiments with Encircling Metal Collars.

No.	Date	Animal and Bone	Period Days	Repair	Anatomical Result	Remarks
4	6/4/11	C. T.	1	None	Lower end had escaped from collar. Fibula fractured	Died, cause undetermined
9	26/4/11	C. T.	52	External periosteal callus outside plate deficient at one area. Ossified only at the edges. Union of bones by cartilage. Remarkable internal reconstruction	Good	Excellent function. Steel plate and wire
10	26/4/11	C. T.	10	None, but bone ends rough. Early callus	Good	Aluminium plate. Wound broke open, exposing plate
11	28/4/11	C. T.	13	Plate largely eroded Early periosteal callus, lower fragment. No union	Good	Magnesium and wire. Good function. Skin became sore
14	1/5/11	C. T.	25	No bony union. Ends partly necrosed. Early callus growing over ends of collar	Good	Aluminium and wire. Excellent function. Fibula thickened opposite fracture
42	19/6/11	C. T.	28	Firm callus union. Tibia fractured	Overlapping and angulation	Wire only. Upper end escaped

Summary.—Mechanically, the method is good. If properly carried out, the bones are kept in good position and good function results; but the natural union is delayed greatly, the bone ends may undergo necrosis, and there is a marked tendency to opening of the wound with exposure of the plate. Very instructive as to the origin of callus.

Intramedullary Pegs (Bone).—In seven experiments I used pegs made of bone or ivory; but as these were only $\frac{1}{8}$ in. to $\frac{5}{32}$ in. in thickness, they were not strong enough to stand the strain put upon them, and in every case the peg was snapped. From a practical point of view, therefore, this series can be dismissed with few words. It is evident that the muscular force which comes into play after a fracture is considerable. It is evinced also by the fact that when the lower leg was the seat of the operation, the fibula usually was also fractured. But the specimens from this series illustrate very well some of the features of repair in the case of mal-united bones, and also afford examples of the formation of false joints.

Fig. 300 shows, in its early stage, the process by which the mal-position of the fragments is minimized by a filling up of angles and concavities with callus. (*a*) is from No. 5 (seventeen days). Displacement is not complete, so that the ends of the fragments are still in apposition, but with some lateral deviation.

The angles between the side of one fragment and the end of the other are filled with callus; this has not formed at all on the surface of the fragments, which are left jutting out. The useful result of this arrangement is clear: the filling up of angles restores the bone to something of its original form, and supports the strain thrown upon it in the original axis. The interesting point arises, however, as to the factors which cause this purposeful remodelling of the bone architecture. The simplest explanation would be that the lateral displacement of the fragments, as seen in *Fig.* 300 *a*, strips off a portion of periosteum, and causes a blood-space, triangular in longitudinal section (shown by the letter **A**), bounded by three surfaces: (1) The outer surface of one end, (2) the cross-section of the other end, and (3) the deep surface of the periosteum. Into this blood-space both the raw bones pour cells which form callus. Where the bone juts out beyond its fellow, the periosteum remains tightly bound to it, and no exudation or callus-formation occurs.

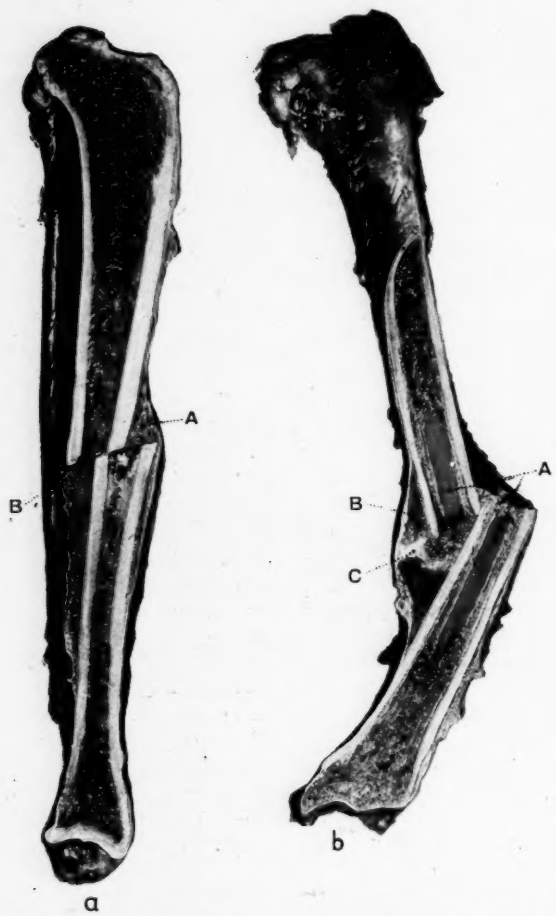


FIG. 300.—TWO CATS' TIBIAS, SHOWING MAL-UNION AFTER MEDULLARY BONE PEGS HAVE BROKEN.

(*a*). No. 5, 17 days after operation. **A**, Early callus filling up the angle between the fragments. **B**, fracture line.

(*b*). No. 6, 44 days after operation: **A**, Broken bone peg. Mass of callus on the concavity only. **B**, Ossified callus next to the bone. **C**, Cartilage still remaining at the site of fracture.

Fig. 300 *b* shows No. 6 (forty-four days). Union has occurred with marked angulation, the concavity of which is filled by callus, partly cartilaginous and partly ossified. That part of the callus which is first formed and is liable to least movement is in the angle between the periosteum and the bone. This is ossified. The part opposite the site of fracture, where movement has continued longest, is still cartilaginous. Here again, the filling up of the concavity of the fracture by callus seems to be determined by the fact that it is at this site that the periosteum is loose and allows exudation. In general terms, therefore, it may be said that in irregular fractures with mal-position, the deposit of callus is determined by an absence of tension, which favours the exudation of bone cells from the ends of the fractured bones.

In *Fig.* 301 *a* and *b*, are seen two specimens of femurs of rabbits showing the formation of false joints: *a* is after thirty-two days, and *b* after forty-seven days. In both there is abundant callus formation, showing that in these cases it is the excessive displacement and mobility which cause the non-union, rather than any absence of reparative capacity. In this respect these cases contrast with the two specimens already figured (*Figs.* 292, 293), in which a

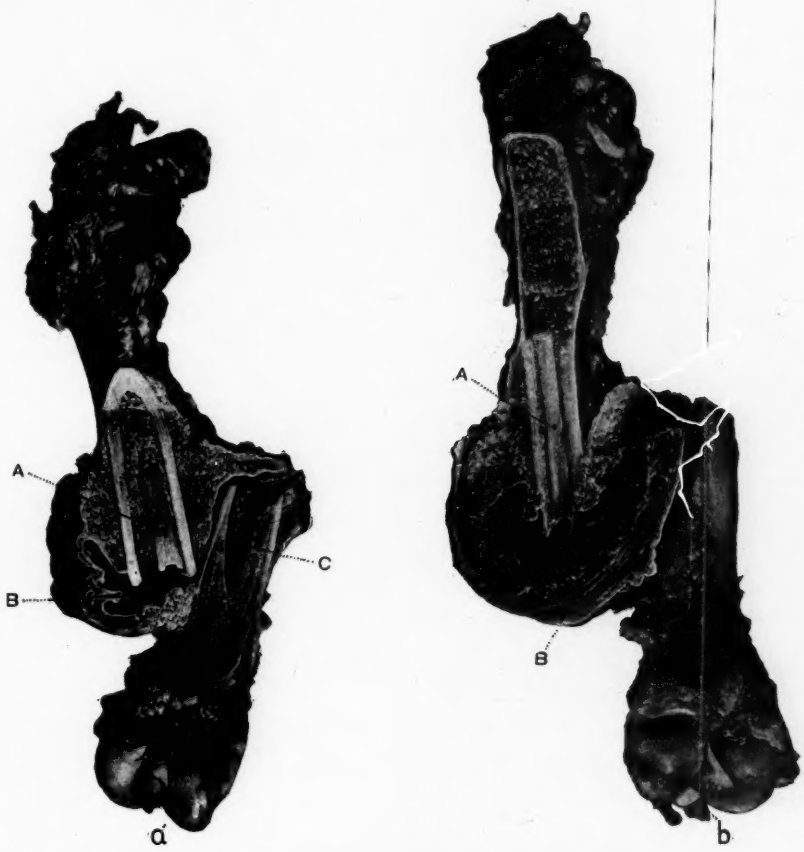


FIG. 301.—FEMURS OF TWO RABBITS, SHOWING THE FORMATION OF FALSE JOINTS AFTER THE GIVING WAY OF MEDULLARY BONE PEGS.

(*a*). No. 15, after 32 days. There is abundant callus formation, especially from the upper end. **A**, Upper fragment of the broken peg. **B**, Cavity of the false joint. **C**, Cavity from which the lower half of the peg has fallen out.

(*b*). No 20, after 47 days. Here, too, there is abundant callus formation. **A**, Broken peg. **B**, Fibrous capsule of the false joint.

scantiness of repair associated with the age of the bones seems to determine the condition. In one respect, however, all the four specimens of false joint which I have encountered in these experiments are similar: they all occurred in either the femur or the tibia of a rabbit; that is to say, in a part of the limb where there is only a single bone (the fibula is only a rudimentary spicule in the rabbit). This would show that free mobility is an important factor in the production of

this condition. As to another factor, often cited as a cause of false joint, viz., the interposition of the soft parts, none of my experimental cases showed any evidence of this.

Table IV.—Results of Seven Experiments with Intramedullary Pegs—Bone.

No.	Date	Animal and Bone	Period Days	Repair	Anatomical Result	Remarks
3	6/4/11	C. T.	5	None	Peg broken. Good alignment	Died, cause unknown
5	12/4/11	C. T.	17	Early callus filling angles	Peg broken. Slight lateral displacement	Slight skin suppuration
6	12/4/11	C. T.	44	Firm callus union. Callus partly cartilage, partly bone	Peg broken. Marked lateral displacement. Fibula fractured	Good active movements
7	21/4/11	C. T.	15	Early callus union	Peg broken. Displacement and overlapping	Some suppuration
15	5/5/11	R. F.	32	Extensive cartilaginous callus with false joint	Peg broken. Marked overlapping	
19	12/5/11	R. F.	45	Inflammatory process has overshadowed any healing	Peg broken out from one end of shaft. Extreme displacement	Osteo-periostitis. No apparent ill-health or pain
20	12/5/11	R. F.	47	False joint with well-marked fibrous capsule	Peg broken. Marked displacement	

Summary.—Mechanically, the method was a failure, because the bone pegs always broke. In three cases there was some suppuration, and in one this was of a serious character. Great displacement, excessive callus, and a tendency to the formation of a false joint were exhibited in the union when the fixation had given way.

Intramedullary Pegs (Decalcified Bone).—These experiments, five in number, met with no success. The peg always gave way and displacement occurred. For practical purposes, therefore, nothing more need be said. Two of the specimens call for comment.

Fig. 302 *a* shows No. 12 (twenty-nine days); there is a large callus mass filling up the angle between the fragments. In this it is easy, even with the naked eye, to trace two stages: (1) Just outside the dense bone of the shaft is a narrow irregular zone of ossification; (2) All the rest of the callus is of a semi-cartilaginous consistency, having originated from the bone.

Now, the ossified portion is the oldest part of the callus, and therefore the position of the ossification points to the originating point of the callus. This, in the specimen, has clearly been from the outer surface of the bone, and not from the deep surface of the periosteum.

Fig. 302 *b* shows No. 39, which is one of the cases of almost entire absence of union with which one is occasionally confronted in bone repair after operation. It is a cat's tibia (twenty-eight days). The skiagram shows practically as much as the specimen itself. The position has been well maintained by a few turns of aluminium-bronze wire outside the periosteum, which embraced the two obliquely-cut ends; but there is not a trace of any kind of callus or

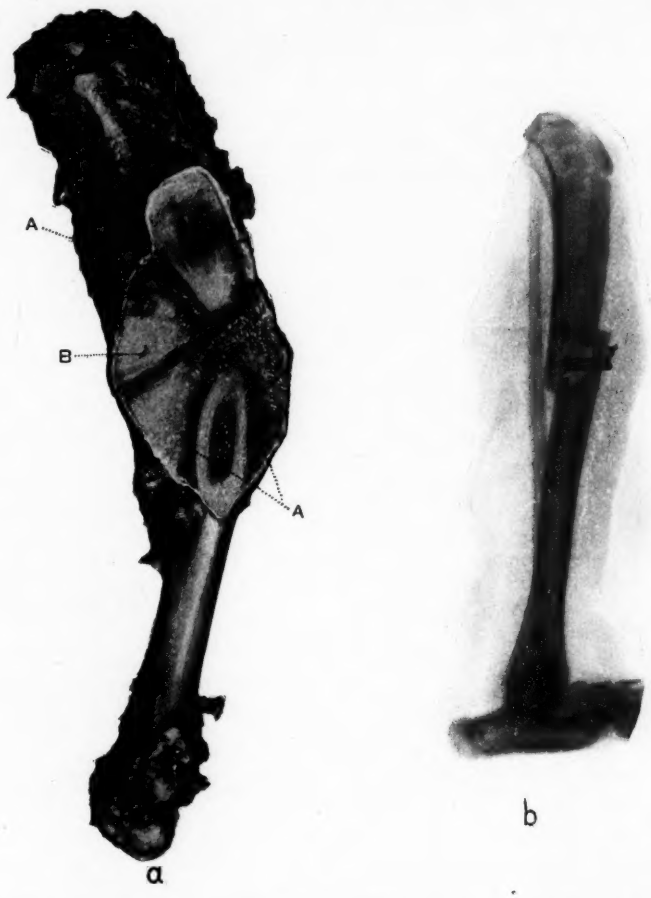


FIG. 302.—TWO CATS' TIBIAS, SHOWING MAL-UNION AFTER THE USE OF DECALCIFIED BONE PEGS.

(*a*). No. 12, after 29 days. A large mass of callus is present, chiefly in the concavity of the fragments. **A**, Ossification of the callus taking place from the surface of the bone. **B**, Wedge-shaped cartilage under the periosteum.

(*b*). No. 39, after 28 days. Skiagram showing the encircling wire and the displacement. There was no callus.

reparative material. The ends of the fragments of bone beyond the wire are necrosed. The section of the bone and the insertion of the peg must have injured their deep blood-supply, whilst the wire interfered with the surface vessels. There is probably a third factor in the matter. I have constantly found that specimens in which aluminium-bronze wire has been used show marked green discoloration of the tissues, and it is likely that this copper

absorption may hinder tissue growth. The specimen is most significant as to the origin of the reparative material from the cut surface of the bone.

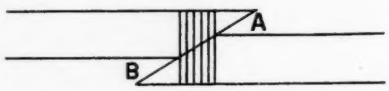


FIG. 303.

The experiment is represented by the diagram (*Fig.* 303), which shows that the obliquely-cut bone ends have slid into the position shown. In normal circumstances healing would occur by the angles A and B being filled by callus. Now the sides of these angles formed by the cut bone is dead, and the other side of the angle is the outer periosteal surface, hence no callus is formed.

Table V.— RESULT OF FIVE EXPERIMENTS WITH INTRAMEDULLARY PEGS— DECALCIFIED BONE.

No.	DATE	ANIMAL AND BONE	PERIOD DAYS	REPAIR	ANATOMICAL RESULT	REMARKS
8	21/4/11	C. T.	28	Callus well marked. Upper end of lower fragment is necrosed	Great overlapping. Fibula fractured	Marked displacement within few days
12	28/4/11	C. T.	29	Union by excessive callus. Necrosis of upper end of lower fragment	Great overlapping. Fibula fractured	Cat well and lively
17	9/5/11	R. T.	10	No union, but no necrosis	Overlapping and angular displacement	Leg put up in plaster
21	12/5/11	R. T.	38	Firm union by external callus	Overlapping with angular displacement	
39	19/6/11	C. T.	28	No union, but position maintained by wire. Necrosis of both ends	Good position	Good function

SUMMARY.—In the absence of other means of support, the method is useless, because the decalcified peg at once snaps.

Intramedullary Pegs (Gelatin and Catgut).—The pegs were made by running gelatin into moulds in which were strands of No. 1 chromic catgut. By this means the pegs, which were hardened in formalin, were prevented from becoming brittle. Only four experiments were performed, all on cats' tibias. The gelatin softened too quickly to allow of any real fixation by this means. Wire, which was used to introduce the pegs, was also wound round the oblique fractures, and it was evidently this wire more than the intramedullary splint that kept the bones in position. In two specimens, No. 34 (twenty-two days) and No. 40 (twenty-eight days), there is no repair of any sort near the fracture. The encircling wire has produced necrosis of the ends of the bones in just the same way as in No. 39 of the last series.

Fig. 304 *a* shows No. 41 (twenty-eight days); there is early union by external callus in good position, but there is no bony union, and part of the ends appears necrosed.

Fig. 304 *b* shows No. 33 (forty days); there is a further stage of union by thick spongy external callus, which is partly ossified, but this is not firm enough to prevent considerable movement between the fragments.

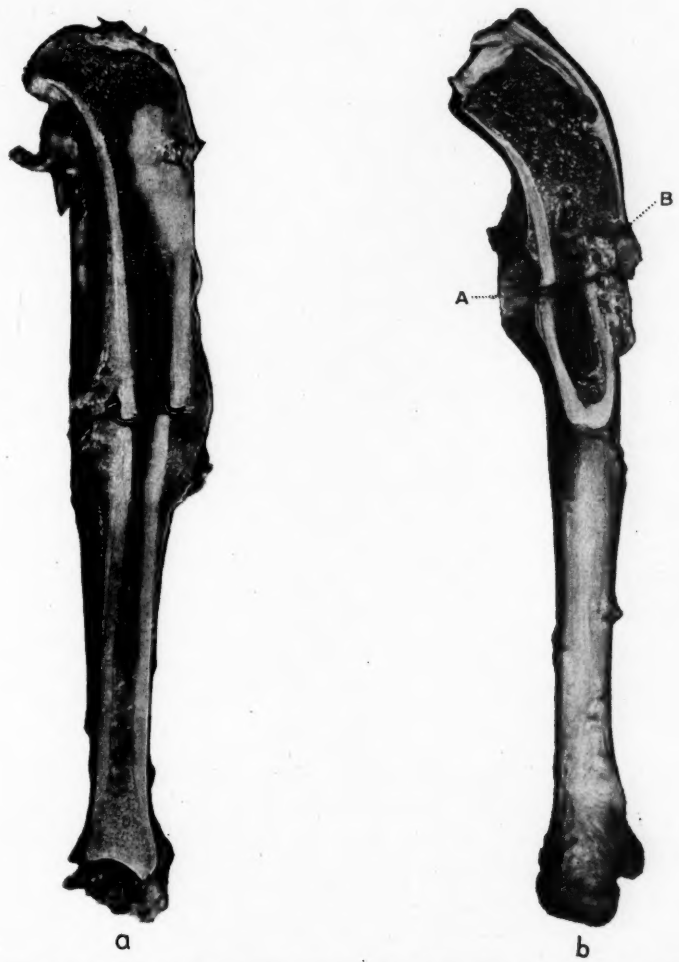


FIG. 304.—TWO CATS' TIBIAS AFTER THE USE OF MEDULLARY PEGS MADE OF CATGUT AND GELATIN.

(*a*). No. 41, after 28 days. Union by external callus. Actual bone ends show partial necrosis.

(*b*). No. 33, after 40 days. A, Remains of catgut peg. B, External callus. Here, too, the actual cut surfaces of the bone show but little repair.

I account for the failure of, or weak, union in these cases by the fact that both intramedullary and periosteal means of fixation were used, thereby interfering with the blood-supply of the bone ends, both from within and from without.

Intramedullary Pegs (Horn).—I only tried horn (which has been spoken of so highly by Rehn) on one occasion. It behaved just like bone or decalcified bone; that is to say, it broke, and allowed great displacement of the fragments. It is evident that it would only be of use when supplemented by external splints, and therefore I did not think it worth while to pursue the matter.

Table VI.—Results of Five Experiments with Intramedullary Pegs—Gelatin (4), Horn (1).

No.	Date	Animal and Bone	Period Days	Repairs	Anatomical Result	Remarks
				Gelatin.		
33	7/6/11	C. T.	40	Union by abundant callus, not by bone. Fibula fractured	Good. The wire had kept the ends in apposition Catgut unaltered	Wire used round oblique division
34	9/6/11	C. T.	22	Almost no repair, even callus absent. Necrosis of ends held by wire	Good, kept by wire	Wire round oblique section
40	19/6/11	C. T.	28	No repair. Ends held by wire necrosed	Good, held by wire	Wire round oblique section
41	19/6/11	C. T.	28	Slight callus repair. Necrosis of ends	Good	Wire round bone section
				Horn.		
45	8/2/12	C. T.	28	Slight callus. No bone union. Fibula fractured	Overlapping. Peg broken	Displacement evident in second week

Summary.—As far as these few cases go, it is evident that absorbable pegs cannot alone hold the bone until union occurs. The effect of the wire in holding the bones together, but in causing necrosis of the bone ends, is important as showing the effect of interference with the periosteal blood-supply.

Intramedullary Pegs (Metallic Magnesium).—As is well known, metallic magnesium is readily disintegrated and absorbed in the living tissues. It seemed, therefore, worth while to try the effect of this metal when used as an intramedullary peg; and the experiments, which were six in number, produced most interesting results.

In four, the femur was the bone used, once of a cat and three times of rabbits. In all of these great displacement occurred, three times from the breaking of the peg, and once from the breaking of the shaft of a rabbit's femur. In these three there was the same excess of callus and new bone that is seen in the tibial specimens, and in two of them (Nos. 22 and 30) the condition was one of periostitis with the formation of abscess cavities. Even in those two specimens where the process was less severe (Nos. 29 and 38), there is a great periosteal thickening of the bone running some distance along the shaft in both directions. The two experiments on the cats' tibias are the best illustration of the results of this method. In both, the anatomical position and the function were good, but there was great excess of callus.

Fig. 305 *b* shows No. 37 (fifty-five days). At the seat of fracture there is spindle-shaped thickening of the bone to about double its natural size. This consists of well-ossified callus, by which the bone is firmly united. In the marrow cavity is seen the disintegrated remains of the peg in the form of opaque whitish masses, interspersed with red material (blood-clot and tissue cells).

Fig. 305 *a* shows No. 35 (sixty-six days), the union is not so good, and the fibula has undergone fracture. Here, too, there is a great callus mass, by which the tibia and the fibula are united to one another. Practically none of the metallic peg remains as such. In the callus there are some islets of cartilage.

FIG. 305.—TWO CATS' TIBIAS AFTER THE USE OF MAGNESIUM PEGS.

(*a*). No. 35, after 66 days. **A**, Remains of the peg. There is fracture of the fibula and great callus excess in both bones.

(*b*). No. 37, after 55 days. **A**, Remains of the peg. **B**, Excessive external callus, firmly ossified.

It is evident from these specimens that magnesium is rapidly disintegrated and absorbed from the medullary cavities of bones. This disintegration is too rapid to allow reliance to be placed on such pegs as the sole means of fixation; but in the process of its absorption, the magnesium evidently acts as a most powerful stimulant to bone-formation. Indeed, it acts as an irritant which may so stimulate the bone as to cause a definite periostitis. This property makes the use of magnesium pegs undesirable in the treatment of ordinary fracture. But it seems to me that if one had to deal with an old un-united fracture, where bone-formation is in abeyance, the method would offer very great advantages, and I should be inclined to adopt it if occasion offered.

Table VII.—Results of Six Experiments with Intramedullary Pegs—Magnesium.

No.	Date	Animal and Bone	Period Days	Repair	Anatomical Result	Remarks
29	19/5/11	R. F.	31	Excessive callus, in which is one small cavity with clear fluid. No bony union	Extreme overlapping, rotation, and angulation. Peg in advanced disintegration	Peg fitted loosely and soon broke. Wound healed well
30	19/5/11	R. F.	42	Exuberant callus and marked periostitis, especially of upper fragment. Several cavities filled with putty-like matter	Great displacement and deformity	Wound healed well. Peg broke
35	9/6/11	C. T.	60	Excessive callus union. Superficial part shows small septic cavity with slight necrosis	Good position. Slight angulation. Fibula and tibia embedded in large callus mass Peg disintegrated	Wound sore. Good function
37	14/6/11	C. T.	55	Spindle-shaped callus mass. Firm union by this. Slight local aseptic necrosis	Excellent	Good function and healing
38	14/6/11	C. F.	55	Excess of callus. Periostitis	Great deformity	Bad function. Peg broke
22	12/5/11	R. F.	38	Upper fragment has split. Periostitis with large abscess	Great deformity	Magnalium rod. Fair function

Summary.—The metal is too soft and easily broken to be relied on, unless supported by another appliance. The great stimulation of callus formation is the outstanding feature.

Intramedullary Pegs (Steel).—Having found that none of the foregoing pegs were rigid or strong enough to be reliable for experimental purposes, I tried solid pegs made of nickel-plated steel. These were of different thicknesses, from $\frac{1}{8}$ in. upwards, varying by $\frac{1}{64}$ in., and $1\frac{1}{2}$ in. long, pointed at both ends. Some were provided with a fixed cross-piece at the centre and inserted into one fragment, and the other fragment was brought over the projecting half. This was the easiest method in the case of the femur. When working with the tibia, it was impossible to separate the ends of the bone enough for this manœuvre, and a different one had to be adopted. The pegs were perforated by a fine hole transverse to their long axis at the centre. The sides of the pegs were grooved along their whole length, and the ends of the transverse hole opened into the grooves. A fine steel wire was threaded through the peg, and its ends were laid along the grooves. The peg was then completely pushed into one fragment, the two fragments brought into line, the ends of the wire pulled upon, and the peg thus drawn up into the other fragment, so that the half peg lay in each half of the bone. The ends of the wire were then twisted together and cut short.

The number of these experiments was seven. Every one succeeded, as judged from the point of view of function. In one case (No. 47, *see Fig.* 307 *c*) a rabbit's femur was split by the peg at the moment of introduction. This led to a badly comminuted fracture, which was encircled by wire. With the exception of this case, all gave a good anatomical result.

As regards the reparative process, a very marked difference was observed in the behaviour of the femur and the tibia. In the former there was some tendency to callus excess ; in the latter, repair was distinctly sub-normal.

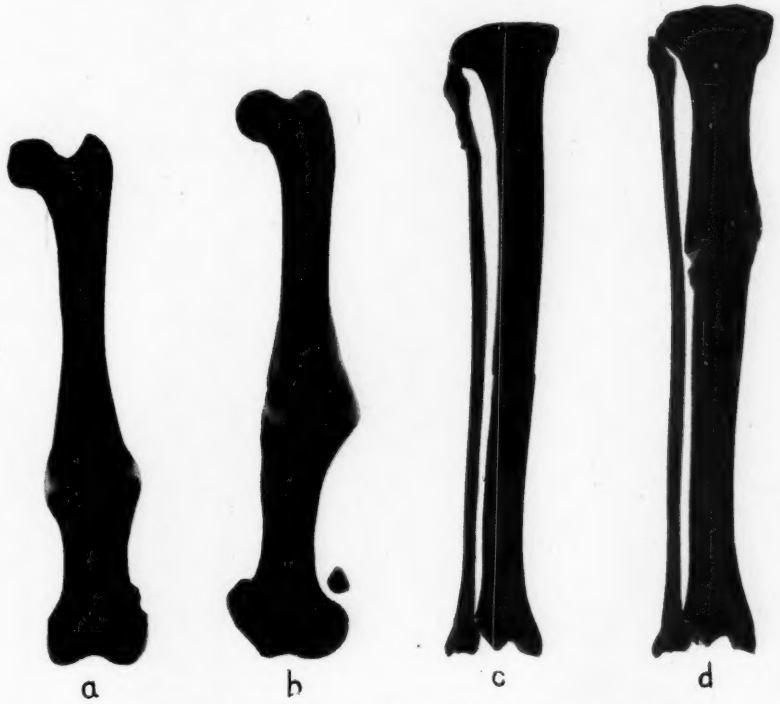


FIG. 306.—SKIAGRAM OF BONES AFTER THE USE OF STEEL MEDULLARY PEGS.

(*a*). Cat's femur (No. 43), after 42 days.
(*b*). Cat's femur (No. 44), after 42 days.
(*c*). Cat's tibia (No. 51), after 14 days.
(*d*). Cat's tibia (No. 56), after 34 days.

There were four experiments on the femur (two cats, two rabbits). In both the cats' femurs (Nos. 43 and 44), seen in *Figs.* 306 and 307, *a* and *b*, the period of observation was six weeks. In one, repair was complete, by a firm external callus and union of the bone ends. In the other, there was rather more callus, but this was partly cartilaginous opposite the line of fracture, and bony union was not complete. In both the rabbits' femurs there was firm though excessive callus, and bony union at periods of thirty-four and forty-three days.

The specimen in which there was the firmest and earliest union was the comminuted case (No. 47, *Fig.* 307 *c*). The peg lies in a comparatively large central cavity, round which there is a shell of new bone nearly $\frac{1}{4}$ in. thick, evidently the result of callus-formation and ossification round each bone splinter

as a centre. This specimen affords evidence of the activity of the bone itself in the process of repair. Instead of repair occurring only from the cut surfaces of the bone, it took place from every separate fragment.

The tibial experiments (*Fig.* 306 *c* and *d*, *Fig.* 307 *d* and *e*) appear at first sight to be even more successful than the femoral. In each of the three cases the bones were in perfect alignment, and the limb was of perfect function; but on cutting open the bones, the process of repair is seen to be defective.

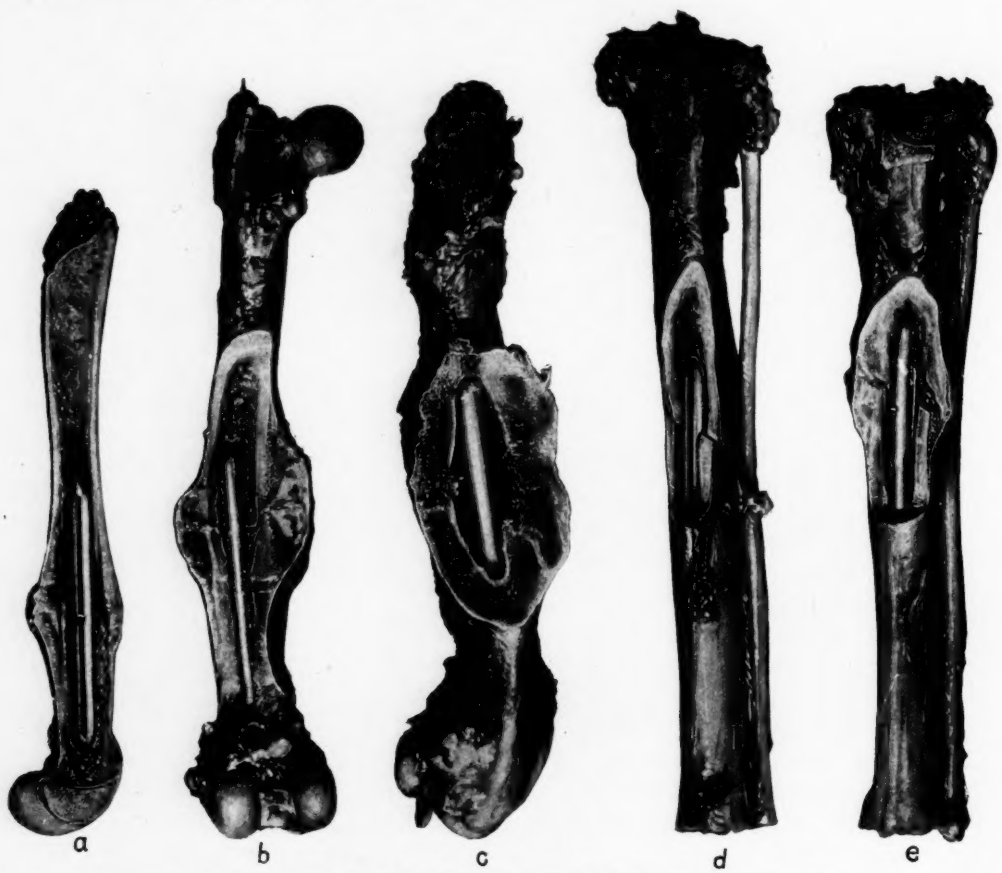


FIG. 307.—BONES AFTER THE USE OF MEDULLARY STEEL PEGS.

(*a*). Cat's femur (No. 43), after 42 days. Firm union by ossified external callus.
(*b*). Cat's femur (No. 44), after 42 days. Firm union, with some excess of external callus. This is still cartilaginous at the line of fracture.
(*c*). Rabbit's femur (No. 47), after 34 days. Bone was splintered by the insertion of the peg, and the parts were surrounded by wire. The peg lies in the centre of a cavity whose walls are formed by a thick layer of new bone formed from the splintered bone.
(*d*). Cat's tibia (No. 51), after 14 days. There is no evidence of repair.
(*e*). Cat's tibia (No. 56), after 34 days. Union is chiefly by external cartilaginous callus.

Figs. 306 *c* and 307 *d* show No. 51 (fourteen days.) The animal was unhealthy, and died at the end of a fortnight. There was no callus and no repair.

Figs. 306 *d* and 307 *e* show No. 56 (thirty-four days); there is moderate callus and early bone union, with the formation of some cartilage at the point of fracture.

In No. 50 (forty-two days) there is no repair visible; the ends of the bone appear to be cut clean and not rounded off, and there is neither effusion nor callus surrounding the seat of fracture. In this case, both ends of the bone had to be bored to take the $\frac{1}{8}$-in. peg, which fitted tightly. Probably in the course of the operation, the periosteum was raised from the bone ends to some extent, and thus the actual cut surfaces of bone were rendered avascular.

Several points are clear. In all, there was anatomical and functional success. In those cases (the femurs) where the peg fitted loosely, there was good union, but callus excess. In the cases (the tibias) where the peg fitted tightly, the repair was delayed. In none of these cases was there any inflammatory or septic complication. This latter fact shows the tolerance of the bones towards foreign bodies of comparatively large size, provided that they be firmly fixed and not chemically affected by the tissues.

Table VIII.—Results of Seven Experiments with Intramedullary Pegs—Steel.

No.	Date	Animal and Bone	Period Days	Repair	Anatomical Result	Remarks
43	25/1/12	C. F.	42	Callus rather excessive. Bone union	Perfect	Peg with fixed cross-piece. Perfect function
44	25/1/12	C. F.	42	Excess of callus, centre of which is cartilage. Bone not united	Perfect. Peg had slipped too far into lower fragment	Peg with wire. Perfect function
47	22/2/12	R. F.	34	Callus excess. Peg lies in centre of a cavity	Deformity. Angular and rotation	Bone splintered and surrounded by wire
49	7/3/12	R. F.	43	Callus excess. Firm union	Good. Peg had slipped too far into lower fragment	Good function
50	2/5/12	C. T.	42	No callus. No union	Good. Peg very firm	Excellent function
51	2/5/12	C. T.	14	Very slight callus. No bone union	Good	Animal never fed properly. Died
56	16/5/12	C. T.	34	Moderate callus. Early bone union	Good	Died of diarrhœa

Summary.—Of the above, No. 47 must be regarded separately, as an accident converted it into a comminuted fracture. All the rest did well. None showed sepsis. The repair is remarkably different. In three femurs the callus is in some excess. In the three tibias it is less than normal, and repair seems to be delayed. Functional and anatomical excellence in every case.

Intramedullary Pegs (Wire Spirals).—One objection to the non-absorbable form of intramedullary peg is that it leaves a large foreign body inside the bone, and if at any time inflammation or sepsis occurs, it will be very difficult to remove it, and the removal will endanger the continuity of

the bone. I have endeavoured to meet this by the construction of wire pegs of longitudinally placed strands surrounded by circular turns, and so made that by leaving the end of the wire outside the bone, the whole peg could be removed by pulling on this end. I may say that in this experimental work I have not been able entirely to succeed, simply because the size of the bones is so small that the spiral cannot be made sufficiently rigid, and the wire is so thin that very often it breaks when pulled upon. In two cases I have succeeded in removing the peg without disturbing the fracture, and I think that with bones having a marrow cavity which will take a $\frac{1}{4}$-in. or larger peg, it is perfectly possible.

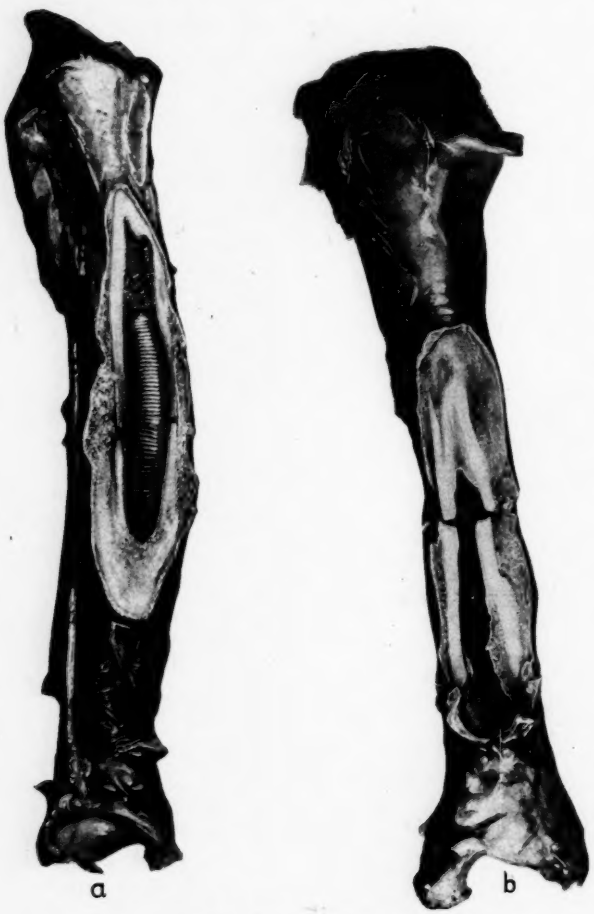


FIG. 308.—TWO CATS' TIBIAS AFTER UNION BY A WIRE SPIRAL INTRAMEDULLARY PEG.

(*a*). No. 64, after 28 days. The peg is still in position. Great periosteal thickening.

(*b*). No. 77, the peg has been removed by unravelling before the specimen was dissected. There is great periosteal thickening. In both cases sepsis occurred, and in both the actual bone ends show no sign of repair.

However, these specimens, apart from the immediate object with which they were undertaken, show some points of interest. In nearly all there was marked angulation from a bending of the peg, and in four out of six there was some sepsis. This latter is of interest in its origin. The technique was exactly the same as when using the solid pegs. Why then was there so much greater liability to sepsis?

The answer to this is found, I think, in the fact that the bones were allowed too free mobility. This produces an excessive effusion, which leaks through the wound, and this leakage causes a contamination from the skin, whilst the copious effusion in the tissues gives an ample soil for the growth of bacteria. The sepsis was trivial, but nevertheless quite important enough completely to modify the aspect of the case.

In all cases there was great thickening of the bones, with excess of callus. This was brought about partly by the over-stimulation of mobility, and partly by the inflammatory irritation.

Fig. 308 *a* is from No. 64 (twenty-eight days). The wire spiral is still in position, and the great periosteal thickening is well shown.

Fig. 308 *b* is from No. 77 (fourteen days), and shows the fracture in good position and undisturbed by the removal of the wire, which had been drawn out before opening the bone.

I think a comparison of the experiments with solid metal and those with wire spiral pegs affords the most convincing demonstration that imperfect fixation, and not the presence of a foreign body, is responsible for both callus excess and the formation of a septic sinus; for in all respects, except that of the rigidity of the peg, these cases were similar. In the one series there was never any sepsis, but in the other it occurred generally.

Table IX.—Results of Six Experiments with Intramedullary Pegs—Wire Spirals.

No.	Date	Animal and Bone	Period Days	Repairs	Anatomical Result	Remarks
61	13/6/12	C. F.	15	Callus in concavity	Extreme angulation	Deformity within first week. Spiral bent
62	27/6/12	C. T.	43	Bone thickened by periostitis. Callus union	Angulation. Fibula fractured	Slight sepsis in wound
63	27/6/12	C. T.	43	Callus union	Angulation Fibula fractured in two places	
64		C. T.	43	Periostitis. Firm callus union	Angulation. Fibula fractured	Slight wound sepsis
66		C. T.	14	Necrosis of one end. No union	Some angulation	Wound sepsis
77		C. T.	28	Periosteal callus. No union	Slight angulation	

Summary.—In no case was the result satisfactory. It is not possible to construct wire spiral pegs of this size with sufficient rigidity.

Transfixion and Extension Apparatus.—All the foregoing methods of operating upon fractures involve a direct attack upon the seat of injury. It is a matter of great importance to compare with these a method which fixes the broken bones without the exposure of the site of fracture,—a method which, whilst maintaining extension, does not rigidly fix the broken ends to one another. For practical purposes this is important, because it illustrates the principles of extension so widely used in human surgery; and on theoretical grounds it is important, because it gives, as no other method can, the stages in repair, uncomplicated by displacement of, or interference with, the parts concerned by any foreign bodies. The method I adopted was as follows: The tibia was perforated at either extremity through minute skin openings by holes which were two and a half inches apart. In order that these should be exactly parallel with one another, the drills were guided by openings in a metal block perforated by parallel holes at the proper distance. Through the holes in the bone were passed two round rods 1 in. long and $\frac{1}{8}$ in. thick, cut at each end with a screw thread for a

nut. Then the bone was divided by the fret-saw about the middle through an incision. The latter is closed in layers, and the parts are clamped into position by placing thin steel bars 2½ in. long on each side, so as to take the ends of the transverse bars. The rectangle thus formed is fixed by four nuts and washers.

This method proved to be simple and very efficacious. The animals ran about with the steel frame in position, and in only one case (the first, when I had not got the suitable drills) was there any sign of inflammation round the transfixion holes. Two cats of this series died of distemper (Nos. 58, 65). In one of these no repair was evident at the end of eighteen days, but in all the other

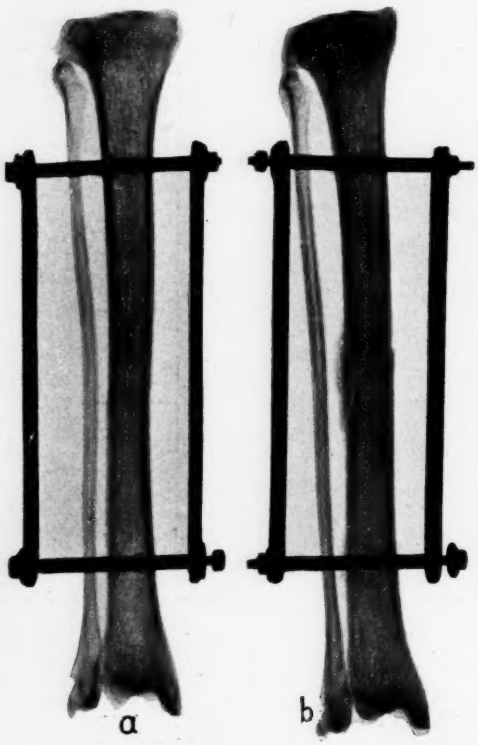


FIG. 309.—SKIAGRAMS OF CATS' TIBIAS TREATED BY TRANSFIXION.
(*a*). No. 65, after 7 days.
(*b*). No. 57, after 14 days.

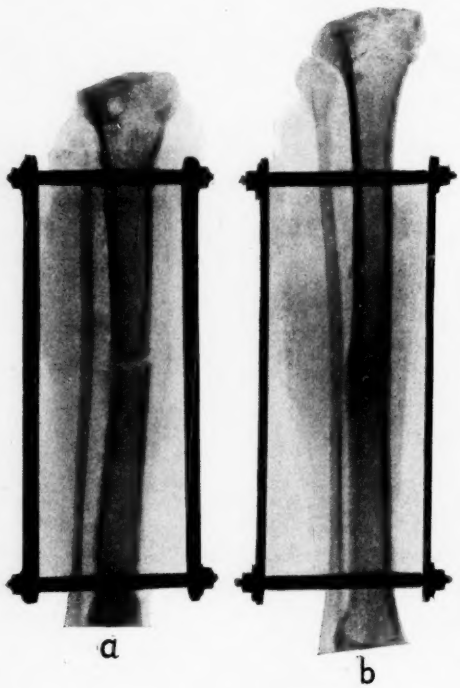


FIG. 310.—SKIAGRAMS OF CATS' TIBIAS AFTER TRANSFIXION.
(*a*). No. 60, after 57 days.
(*b*). No. 59, after 71 days.

five cases, repair proceeded regularly. It will be convenient to describe these five in the order of the length of period during which they were under observation.

Figs. 309 and 310 are skiagrams showing some of the specimens at intervals varying from seven to seventy days. They show how well the position of the bones is maintained, and how little irritation occurs at the site of perforation.

Fig. 311 *a*, No. 65 (seven days), shows merely a small quantity of blood-clot beneath the periosteum and in the marrow cavity.

Fig. 311 *b*, No. 57 (fourteen days). There is a layer of external callus, about the same thickness as that of the compact bone beneath. The callus is uniformly calcified, and extends about ¼ in. above and below the fracture. Inside the

marrow cavity there is a very definite internal callus plug in the upper, but not in the lower, fragment. The line of bone-division is still clearly defined. There is a curious islet of cartilage in the marrow cavity of the upper fragment, about half an inch from the fracture.

Fig. 312 *a* shows No. 55 (twenty-one days). The same condition is seen as in the last case, except that the external callus is distinctly cartilaginous. The same difference is seen as in the last specimen, between the upper and lower fragment, in respect to the presence of internal callus in the former and its absence in the latter.

Fig. 312 *b* shows No. 60 (fifty-seven days). The bone is firmly united, and only a linear trace of the fracture can be seen on naked-eye examination of the section. There is a small amount of external callus and a solid internal callus. This and the following specimen represent the most perfect union that I have ever attained in experimental operations.

Fig. 312 *c* shows No. 57 (seventy - one days). Exactly the same conditions are found as in the last case, i.e., a solidification of the fracture, together with a minimum amount of external and internal callus. It is especially interesting, as showing the complete absence of irritation at the two points where the bone is perforated and in which steel bars have been resting for over ten weeks.

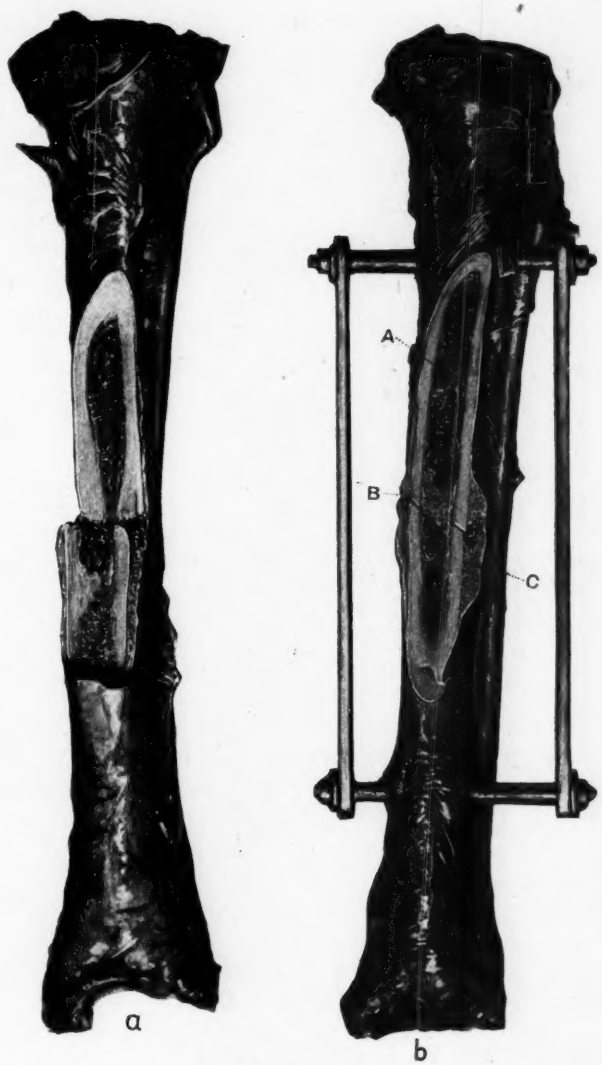


FIG. 311.—CATS' TIBIAS AFTER TRANSFIXION.

(*a*). No. 65, after 7 days. The ends of the bone have a small quantity of blood and granulation tissue between them. (*b*). No. 57, after 14 days. Early ideal repair. A, Islet of cartilage present in the medulla far from the fracture. B Internal callus present only in the upper fragment. C, External callus.

There can be no doubt, as far as the evidence of these experiments goes, that this method of indirect fixation of the fracture gives a more perfect union of the bones than any direct method that I have performed. It may be objected that

the experimental conditions, in which fixation is provided for before any displacement has taken place, are much more favourable than can be attained in human surgery. But on the other hand, in every one of these cases the periosteum has been divided and the bone cut by a straight smooth saw-cut, both of which conditions are unfavourable to repair in comparison with those obtaining in simple

FIG. 312.—CATS' TIBIAS AFTER TRANSFIXION.

(*a*). No. 57, after 14 days. A, Internal callus present only in the upper fragment. B, External callus.
(*b*). No. 60, after 57 days. Perfect internal and intermediate callus.
(*c*). No. 59, after 71 days. Perfect union by means of a minimum of callus.

fractures, when the periosteum is often not severed, and in which the jagged bone-break gives a far better surface for repair.

The small quantity of callus formed is noteworthy, and is associated, no doubt, with the absence of friction between the bone ends.

Table X.—Results of Six Experiments with Transfixion Apparatus.

No.	Date	Animal and Bone	Period Days	Repair	Anatomical Result	Remarks
55	16/5/12	C. T.	21	Early callus	Angulation. Fibula fractured	Faulty technique. Boring difficult Soft parts torn. Wound suppurated
57	30/5/12	C. T.	14	Firm callus union	Excellent	Good technique. Good function
58	30/5/12	C. T.	18	No repair, callus or bony	Excellent	Good function. Never well. Died of distemper
59	30/5/12	C. T.	71	Bony union. Minimum callus	Excellent	Good function from 2nd week
60	13/6/12	C. T.	57	Bony union. Minimum callus	Excellent	Good function
65	27/6/12	C. T.	7	Early stages of repair	Excellent	Cat never well. Would not feed. Died of distemper

Summary.—Every case did well except the first, in which the technique was at fault. The good anatomical result, the repair with so little callus, and the early functional recovery, are very notable.

COMMINUTED FRACTURES.

The use of the transfixion apparatus described in the last section rendered it comparatively easy to undertake the study of comminuted fractures. The technique of these operations was the same as the last, except that the bone was crushed by a forceps for a distance of about ½ in., instead of being divided by a fret-saw. After this had been done, one of three different courses was pursued :—

(1) *The fragments and periosteum were left in situ ;* or (2) *All the loose fragments were removed, but the periosteum left*; or (3) *The broken bone was surrounded by a thin aluminium plate, which excluded the periosteum from the fragments.*

In all cases the soft parts and skin were closed over the site of fracture. It will be convenient to describe the results of each class separately, before discussing the merits of this method for the treatment of severely crushed bones.

1. **Fragments and Periosteum Left in Situ.**—There are three cases in this series (shown in *Fig.* 313 *a, b, c*), all of them being cats' tibias. The period of observation was twenty-eight days in two cases and forty-two in the third. In two (Nos. 67 and 72) the position was well maintained, and except for some thickening of the bone in No. 72, the bones were restored to a close approach to the normal form. The functional results were uniformly good. The animals after the first week used the injured limb quite freely, and often ran without any appreciable limp.

The union in all these cases was firm and solid, the fragments being embedded

in callus. In fact, these cases exhibit the most rapid and firm union of any experimental fracture that I have seen.

Fig. 313 *a* shows No. 67 (twenty-eight days). There is firm union in good position without callus excess. There seems to have been a posterior splinter

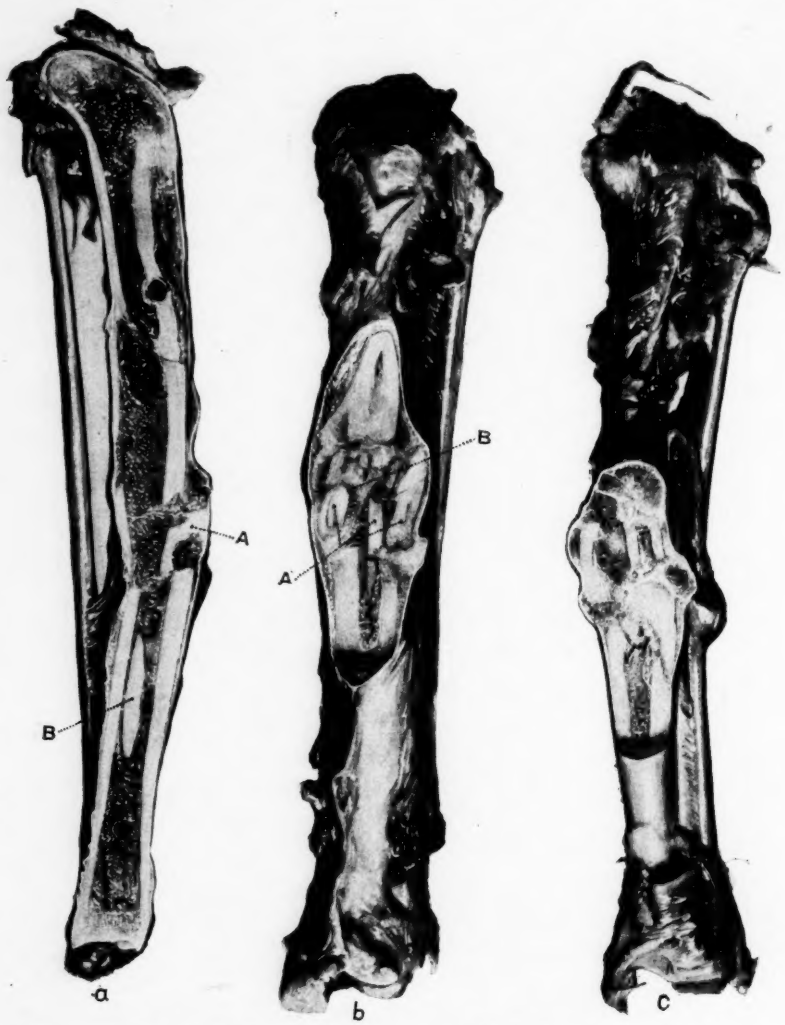


FIG. 313.—THREE CATS' TIBIAS, COMMINUTED. FRAGMENTS LEFT IN POSITION.
(*a*). No. 67, after 28 days. A, One of the fragments. B, A fragment which has slipped down into the marrow cavity.
(*b*). No. 72, after 28 days. A, Small fragments of bone. B. Callus growing from these fragments.
(*c*). No. 68, after 42 days.

of bone left connecting the main fragments, which would therefore have served to keep the parts more firmly fixed than in those cases where there was complete solution of continuity. In the upper fragment the medullary cavity is filled by a firm mass of callus extending about half an inch from the fracture. This is less marked in the lower fragment.

Fig. 313 *b* shows No. 72 (twenty-eight days). There is a large, spindle-shaped mass at the site of injury. The line of the bone is well preserved. The thickening consists of all the fragments welded together in firm callus which is in an advanced stage of organization, so that there is solid union of the fracture. In this mass, surrounded by the periosteum, there is no distinction between external and internal callus ; but the dense fragments of bone can be distinguished from the intervening callus with its more open structure. There is, in fact, a strong and solid union.

Fig. 313 *c* shows No. 68 (forty-two days). There has been some fault in the upper transfixion hole. Either this was made too large, or else it became enlarged by inflammation ; but the result has been that fixation was not secure, and the fibula has fractured and the bones are angulated. There is the same solid mass of bone fragment embedded in callus as in the preceding specimen.

Table XI. Three Experiments on Comminuted Fractures with Transfixion Apparatus. Fragments and Periosteum Left in Situ.

No.	Date	Animal and Bone	Period Days	Repair	Anatomical Result	Remarks
67	5/9/12	C. T.	28	Firm welding of fragments in callus	Good, with some thickening	Cat ran freely one week after operation
68	5/9/12	C. T.	42	Firm welding of fragments in callus	Angulation. Fibula fractured. Upper pin-hole too large	Good function
72	19/9/12	C. T.	28	Firm callus mass embedding all the fragments	Good	Walks well

Summary.—The result was good. Repair firm, with a tendency to callus excess and bony thickening. Repair is quicker and better than in those cases where either periosteum or fragments are removed.

2. **Fragments Removed.**—There were four experiments upon cats' tibias. In one the lower transfixion hole had been made through the front surface of the bone, and the transfixion bar had worked loose. In this the fibula had broken and the tibia was angulated. In all the others the anatomical result was good. The functional condition was not so good as in the last series, and the animals appeared reluctant to place their weight on the leg, so that although they could walk, this was with a marked limp.

As regards repair, all the specimens show the same general condition, with remarkably little difference according to the period (varying from three to six weeks). To the naked eye, the longitudinal section shows that the continuity of the bone is restored with great exactness ; but the material of repair is merely fibrous or cartilaginous callus, with but little evidence of ossification.

Fig. 314 *a* shows No. 69 (twenty-one days). There is marked angulation. The whole space between the bone ends is occupied by a mass of fibro-cartilage which merges into the structure of the dense bone by a callus of firmer texture.

Fig. 314 *b* shows No. 70 (forty-two days). The restoration of the form of the bone is almost exact, but the gap between the bone ends is filled by cartilaginous callus.

Fig. 315 *a* shows No. 71 (twenty-one days). The alignment is good. The gap between the bones is not completely filled to the same thickness as the shaft.

FIG. 314.—CATS' TIBIAS. COMMINUTED FRACTURE. FRAGMENTS REMOVED.

(*a*). No. 69, after 21 days. A, Ossified callus on the surface of the lower fragment. B, Fibrous callus in the middle of the gap. There is one small piece of bone in this gap, but from its firm texture and sharp outline it is evidently a fragment which has been left, and not a new formation.

(*b*). No. 70, after 42 days. Callus is ossified where it touches the bone ends, but cartilaginous in the centre.

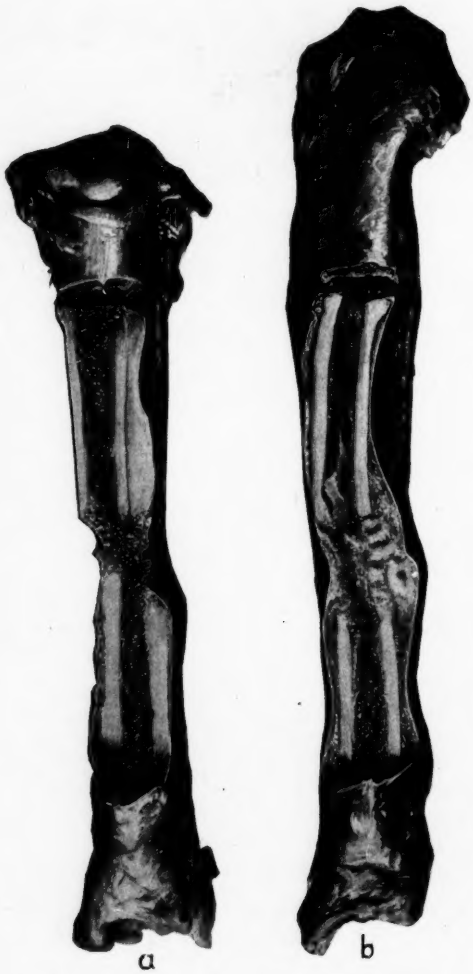


FIG. 315.—CATS' TIBIAS. COMMINUTED FRACTURES. FRAGMENTS REMOVED.

(*a*). No. 71, after 21 days.

(*b*). No. 73, after 28 days.

Fig. 315 *b* shows No. 73 (twenty-eight days). The union has a very solid appearance, but it consists of cartilage, in which there are a few islets of a more calcified material.

An interesting fact in this series is the great contrast afforded by the *x*-ray pictures and the naked-eye appearance of the specimens. In the one (*Fig.* 316) it looks as though there was nothing filling up the gap between the ends of the bone, whilst in the other, continuity appears to have been completely restored.

FIG. 316.—Skiagram of cat's tibia (No. 70), 42 days after comminution and removal of fragments. Contrast the apparent absence of repair with the drawing of the same specimen in 314 *b*.

Table XII. FOUR EXPERIMENTS ON COMMINUTED FRACTURES WITH TRANSFIXION APPARATUS. REMOVAL OF LOOSE FRAGMENTS.

No.	DATE	ANIMAL AND BONE	PERIOD DAYS	REPAIR	ANATOMICAL RESULT	REMARKS
69	12/9/12	C. T.	21	Definite solid mass of soft callus between the two ends	Angulation. Fracture of fibula	Limped badly. Upper pin only caught edge of tibia and had broken out
70	12/9/12	C. T.	42	Union by solid mass of calcareous callus, not rigid	Good	Walked with a limp
71	12/9/12	C. T.	21	Union by solid callus and by a splinter of bone	Good	Apparatus became unscrewed
73	19/9/12	C. T.	28	Restoration of bone by callus which is partly cartilage	Good	Walked badly

SUMMARY.—Cartilaginous and fibrous callus is rapidly formed and replaces the lost bone; but ossification is long delayed.

3. **Exclusion of Periosteum.**—In this series there were only four experiments, and of these, two are of no value. In one (No. 74), the animal died the day following the operation, from some undetermined cause; and in the other (No. 76) sepsis occurred, and all the fragments underwent necrosis.

The remaining two specimens, Nos. 78 and 75, were of periods of thirty-five

and forty-two days respectively; in both there was a good anatomical result, and in one (75) the animal walked well.

Fig. 317 *a* shows No. 75 (forty-two days). The bone is in good alignment. The small fragments are joined to one another and to the upper half of the bone by firm callus, but there is still some mobility possible between the fractured fragments and the lower half of the bone. There is very definite advanced internal callus present between the small fragments and the upper half of the shaft. Between the dense bone and the plate there is a thin layer of soft material like lymph, but no callus. The periosteum is in a very different condition in different parts of the longitudinal section. On the left, it appears to be perfectly unchanged, neither thickened nor ossified. On the right, it presents a definite firm layer of tissue about $\frac{1}{16}$ in. thick. At each side this layer is continuous with the shell of external callus on the outer surface of the main halves of the bone; here it is thicker, and is certainly ossified. In the centre, the periosteal bridge is thin and soft. Between the ends and the centre there are transitional areas of cartilage. This structure shows that the subperiosteal callus layer is being laid down in the angle of junction of the periosteum and bone, and not by the whole of the deep surface of the periosteum.

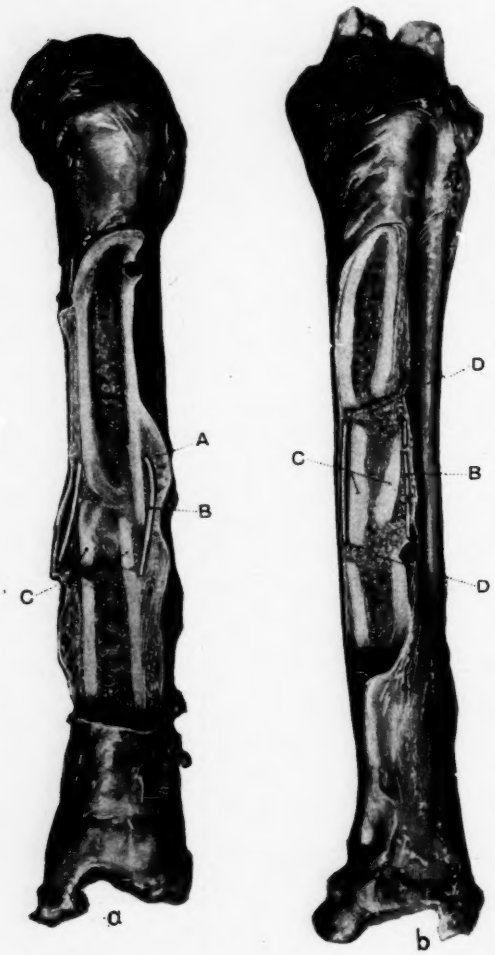


FIG. 317.—CATS' TIBIAS. COMMINUTED FRACTURES, SURROUNDED BY ALUMINIUM PLATE.

(*a*). No. 75, after 42 days. A, External callus growing from the angle between the bone and the periosteum. B, Plate. C, Separate fragments of bone.

(*b*). No. 78, after 35 days. B, Plate. C, Separate fragments. D, Internal callus at junction of the comminuted part with the main parts of the shaft on either side.

Fig. 317 *b* shows No. 78 (thirty-five days). It reveals a rather tardy union of the bones, and there is distinct mobility between both the main parts of the bone above and below, and the comminuted portion in the centre. This latter exhibits a marked thickening of the fragments. No external callus is visible outside the metal plate, and the periosteum appears to be quite unchanged. There is some internal ossified callus at the junction of the comminuted part with the main parts of the bone on each side. Both these specimens show that the comminuted fragments are the centre of active reparative changes, although

isolated from the periosteum. At the same time these changes are much delayed, and their vigour impaired, by the periosteal exclusion.

Table XIII. Four Experiments on Comminuted Fractures with Transfixion Apparatus, with Exclusion of Periosteum.

No.	Date	Animal and Bone	Period Days	Repair	Anatomical Result	Remarks
74	19/9/12	C. T.	1	None	Good	Died, cause not found
75	3/10/12	C. T.	42	Fragments appear to have grown together, but there is little union with bone beyond fracture. No external callus	Good. Slight angulation	Walked well. Aluminium plate
76	3/10/12	C. T.	21	No union. All fragments necrosed	Good	Sepsis
78		C. T.	35	Union of fragments to upper pair of main shaft. Periosteal callus growing over plate from the edges	Good	Walked badly

Summary.—It is clear that vitality and repair are preserved, but that callus formation, and therefore effective rapid union, is greatly delayed when the periosteum is separated from the seat of fracture.

In considering this series of eleven comminuted fractures, there are several important conclusions to be drawn.

From the practical standpoint it is evident that the method of indirect fixation of the ends of the bone, leaving the site of fracture untouched, is a good one. It is a method which will be of great utility in dealing with both compound and comminuted fractures in surgical practice. The length and alignment of the bone are accurately preserved, and at the same time the joints above and below the fracture can be exercised from the very first. It combines the advantages of the methods of extension with those of the methods of early massage and movements.

Next, as to the origin of the reparative callus. This is seen to arise from the bone itself rather than from the periosteum. When there is much raw bone surface, the callus forms from many centres and is rapidly matured. Where the bone fragments are removed, callus is poured out into the periosteal tube, chiefly from the cut ends of the bone; but it is a much slower process. When the periosteum is excluded, union by callus still occurs, but the field of repair, being shut out from the vascular supply of the periosteum, produces its callus slowly and in small quantities.

As every fragment in a comminuted fracture is a focus of repair, it follows that every fragment ought to be retained in the interests of quick and firm union. But where mobility rather than strength is required, as in the neighbourhood of a joint, it will often be better to remove loose fragments, lest excessive callus cause joint fixation. Any direct operative attack upon a comminuted fracture will involve the risk of interfering with the vitality of the fragments, and therefore lessening their ability to act as a centre of repair.

Indirect Fixation of the Femur.—The method of indirect fixation by transfixion of the bone, which is so excellent in the case of the tibia, cannot be applied without modification to the upper part of either limb, because in both cases the upper portion of the bones (humerus and femur) cannot be transfixed, or rather, a transfixion rod cannot be brought to the surface, because in the one case it would lie in the axilla, and in the other in the perineum.

I thought to solve this difficulty by unilateral transfixion. Two screws were passed into and through the femur, one just below the trochanters and one just above the condyles. Each was provided with a rim or shoulder which held firmly against the bone surface when the screw was driven home tightly. After dividing the bone between the screws, the soft parts were united and the ends of the screws left protruding beyond the skin. These were then fixed to a steel bar by nuts.

FIG. 318.—Cat's femur (No. 82), forty-two days after operation. Treated by unilateral screw fixation. There is much angulation, and a great thickening round the upper screw-hole. I. C, Internal callus.

Much to my surprise all four of these experiments failed to give a satisfactory result. That is to say, in three out of four, one screw came out of the bone and gross deformity resulted, and in the only one in which the apparatus remained in place, very considerable angulation resulted. In two cases the screws were fixed at a slightly divergent angle to the longitudinal bar, so that the tension of the muscles should tend rather to pull the bones more firmly on to the screws; but the result was no better.

These screws were one-eighth inch in diameter, with a stout thread, and yet within much less time than is occupied in consolidation of the bone, they generally worked loose. This is in accordance with what has been stated above as to the reaction of metal screws tightly driven into hard bones.

Fig. 318 is from experiment No. 82, a cat's femur forty-two days after operation. There is a marked angulation in a posterior direction, with much callus thickening round the upper screw-hole. Natural callus is well developed, but union is not yet osseous.

TABLE SHOWING THE RESULTS OF UNILATERAL FIXATION OF THE FEMUR.

DATE	NO. OF EXP.	PERIOD DAYS	ANATOMY	HEALING	REMARKS
5/6/13	81	14	Gross deformity	Good internal callus	Upper screw came out
5/6/13	82	42	Some angulation	Union chiefly by internal callus	Apparent success
26/6/13	87	21	Gross deformity	Internal callus only	Upper screw came out
28/8/13	90	14	Gross deformity	None	Upper screw came out

SUMMARY.—These failures show that a single bone cannot be kept in good position by an apparatus which holds it by two points only without exercising continuous extension.

Regeneration of Bone after Subperiosteal Removal of a Portion of its Entire Thickness.—The transfixion apparatus having proved itself such an excellent device for studying the repair of simple and comminuted fractures, it seemed a good method for observing the repair which occurs when a piece of the entire thickness of the bone is removed.

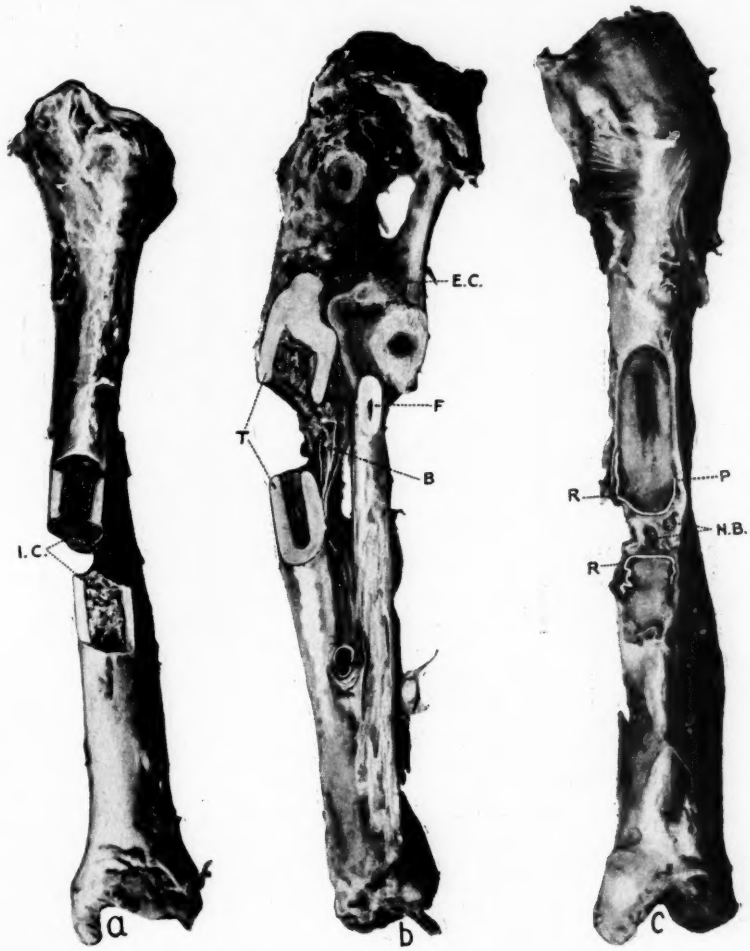


FIG. 319.—CATS' TIBIAS AFTER SUBPERIOSTEAL REMOVAL OF A PORTION OF THE SHAFT IN ITS WHOLE THICKNESS.

(*a*). No. 80, after 14 days. Internal callus best developed in upper fragment. Nothing in gap. **I, C**, Internal callus.

(*b*.) No. 79, after 35 days. Fibula has broken. In the tibial gap there is no new bone, but round the fibular ends there is a big mass of new bone. **T**, Tibial ends. **F**, Fibula. **E. C**, External callus. **B**, Bridge of soft tissues only in the gap between bone ends.

(*c*). No. 85, after 42 days. The ends of the bone have been covered in by rubber tissue; but in spite of this the gap is filled by callus, both cartilage and bone, derived from the periosteum. **P**, Periosteum. **R**, Rubber tissue. **N. B**, New bone in the cartilaginous callus mass.

In all cases the cat's left tibia was the subject of the experiment, and a section of the bone, about half an inch in length, was removed subperiosteally by means of two saw-cuts. There were five experiments in this group; in the

first three, the cut ends of the bone were left bare, and in the last two they were covered in thin rubber, tied on with a fine wire.

Fig. 319 *a* is from No. 80, fourteen days after the operation. There is seen a healthy and fairly vigorous formation of internal callus from the upper fragment, and much less from the lower. Otherwise there is no trace of any callus or reparative material between the bone ends. The callus mass growing from the upper fragment is very sharply defined, and gives the impression of merely forming a cap for the bone end, rather than a bridge that is going to stretch across the gap.

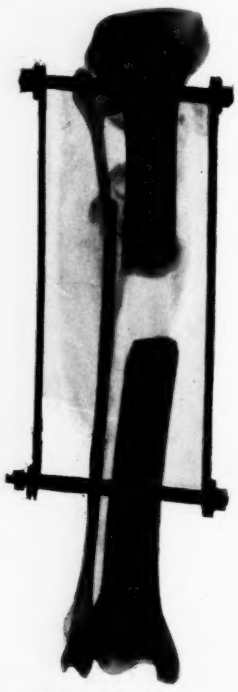


FIG. 320.—Cat's tibia (No. 79). Skiagram of specimen shown in 319 *b*. There is complete absence of bone in the gap after 135 days.

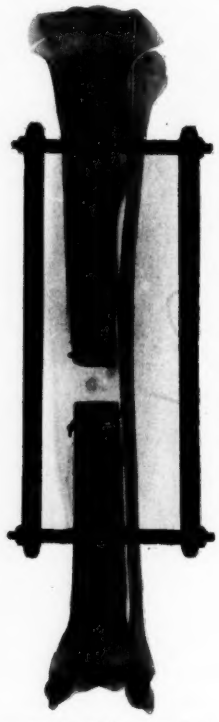


FIG. 321.—Cat's tibia (No. 85). Skiagram of the specimen shown in Fig. 319 *c*. Two nodules of bone are seen in the gap.

In *Fig.* 319 *b* is seen No. 79, thirty-five days after operation, and here too there is a perfectly clear interval between the cut ends of the tibia, with no suggestion of new bone or callus. In this case, the fibula has fractured and the exuberant callus formed round the broken ends of the fibula would have been more than enough to fill the gap in the tibia. Thus there is a striking example of the absence of callus when bone ends are not in contact, and the exuberance of callus formed by broken bone ends which are allowed some movement against each other.

In the three cases, Nos. 79, 80, and 83, there was no trace of callus being laid down by the periosteum, and much less pouring out of callus from the cut bone ends than I expected. In the two cases 84 and 85, I wished to eliminate this last factor, and for this purpose a small fragment of rubber tissue from a glove was tied over the cut ends of the bone. In both these there

was found perfectly normal internal callus formation beneath the rubber tissue, proving that such callus is derived from the bone and its marrow cavity, and not from the periosteum. In No. 85, however, a surprise was in store. The specimen is illustrated both by skiagram and by drawing (*Figs.* 321 and 319 *c*). There is here unquestionably an advanced callus formation between the rubber-covered bone ends and the periosteal sheath. This is chiefly cartilaginous, but there is a well-marked bone nodule in its centre, which is dense enough to show in the skiagram. It is impossible to avoid the conclusion that in this case, at any rate, the periosteum has laid down the new bone.

TABLE SHOWING RESULTS OF THE SUBPERIOSTEAL REMOVAL OF A PART OF THE WHOLE THICKNESS OF THE BONE.

DATE	NO.	PERIOD DAYS	ANATOMY	HEALING	REMARKS
15/5/13	79	35	Fibula had broken	Internal callus in upper fragment. Nothing in gap. Callus excess round fibula	Good function
15/5/13	80	14	Good position	Internal callus in upper fragment	Died—cause unknown
19/6/13	83	7	Good position	No repair	Good function. Died—cause unknown
19/6/13	84	7	Good position	Early stage of internal callus under rubber	Rubber tied over bone ends
19/6/13	85	42	Good position	Internal callus in both ends under the rubber, and a a mass of cartilaginous and bony callus formed from periosteum in gap	Rubber tied over bone ends. Good function

SUMMARY.—From a practical point of view, this small series of cases shows that in the majority of cases bone is formed very scantily or not at all from bone ends which are separated from one another by a considerable gap.

Regeneration of Bone when a Part only of the Thickness has been Removed.—These four experiments were undertaken in connection with the subject of bone transplantation, which cannot be discussed in any detail here. The skiagrams are merely shown to illustrate the rapid repair which takes place when a part only in the thickness of the shaft is removed. The anterior border of the tibia was exposed, and a piece 1 in. long sawn from the bone, so as to remove about half its entire thickness. This piece was then split into two equal parts, and one was grafted whole and the other after minute subdivisions, under the fascia lata of the thigh. In all cases the grafts lived. The whole graft seemed to remain unchanged, whilst the comminuted graft formed a bone mass of some size.

Figs. 322, 323 and 324 show the tibia after intervals of twenty-eight, sixty, and sixty-three days, and in the last two it will be seen how completely the gap in the tibia has been replaced.

FIG. 322.—No. 96, after 28 days. Leg bones of a cat. A piece has been removed from the tibia and grafted in two parts in the thigh—a single piece and a number of chips.

FIG. 323.—No. 94, showing regeneration of the cat's tibia after 60 days.

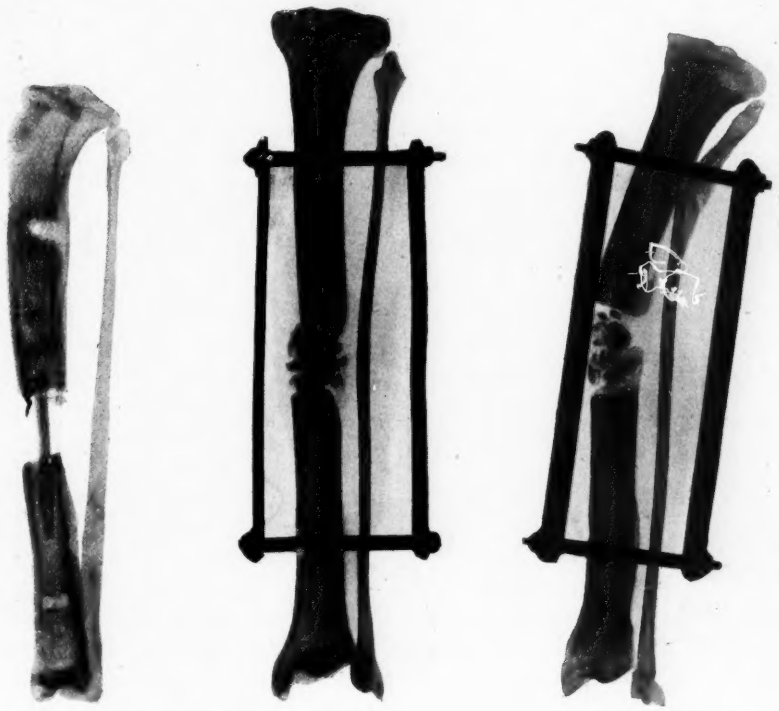
FIG. 324.—No. 91, showing regeneration of tibia after 63 days.

TABLE OF EXPERIMENTS ON REMOVAL OF A PART OF THE THICKNESS OF A LONG BONE.

DATE	No.	PERIOD DAYS	REMARKS
12/9/13	96	28	Gap is partly filled with cartilaginous callus. There is new bone formed in the marrow cavity
12/9/13	95	60	Gap is almost completely filled with bone of normal density
12/9/13	94	60	Gap completely filled with bone of normal density
28/8/13	91	63	Gap is filled with bone, and the marrow cavity somewhat encroached upon by new dense bone

SUMMARY.—A large defect in the bone, affecting only half its thickness, is rapidly made good, probably by regeneration from the raw bone surface left.

Experiments in Filling a Bone Defect by a Single large Piece or by many small Chips.—These experiments are at present only three in number, and therefore not very conclusive, but they are interesting as far as they go. In all cases the leg was put up in the transfixion apparatus. In the first case, the gap in the tibia was made good by a rod cut from the opposite leg bone and thrust into the marrow cavity of both bone ends. After forty-nine days the specimen (*Figs.* 325 *a* and 326 *a*) shows a good solid union. The bone as a whole gives a feeling of perfect solidity. The graft is embedded in callus which is chiefly cartilaginous, and there is certainly a structural continuity between this



a *b* *c*

FIG. 325.—SKIAGRAMS OF CATS' TIBIAS, WITH FRAGMENTS GRAFTED.

(*a*). No. 86, after 49 days. Single graft in the form of an intramedullary peg.
(*b*). No. 88, after 15 days, showing separate fragments.
(*c*). No. 89, after 70 days. The chips are still quite discrete.

callus and the graft. Whether the callus has grown from, or merely grown into the graft, is impossible to say.

Figs. 325 *b* and *c* and 326 *b* and *c*, illustrate the two specimens in which a piece of the tibia was cut out and then replaced after crushing up into small pieces. The skiagrams are remarkable for the great similarity between (*b*) after only fifteen days, and (*c*) after seventy days. Both the drawings show that the particles of bone are embedded in callus, but in neither is any solidity attained. In (*b*) the callus is only cellular, in (*c*) it is partly cartilaginous. The manner in which some of the particles remain clean cut and apparently inert, forms a very sharp contrast to the condition of affairs in

which the bone was merely crushed but the particles were not removed from their bed (*see Fig.* 313, *b* and *c*).

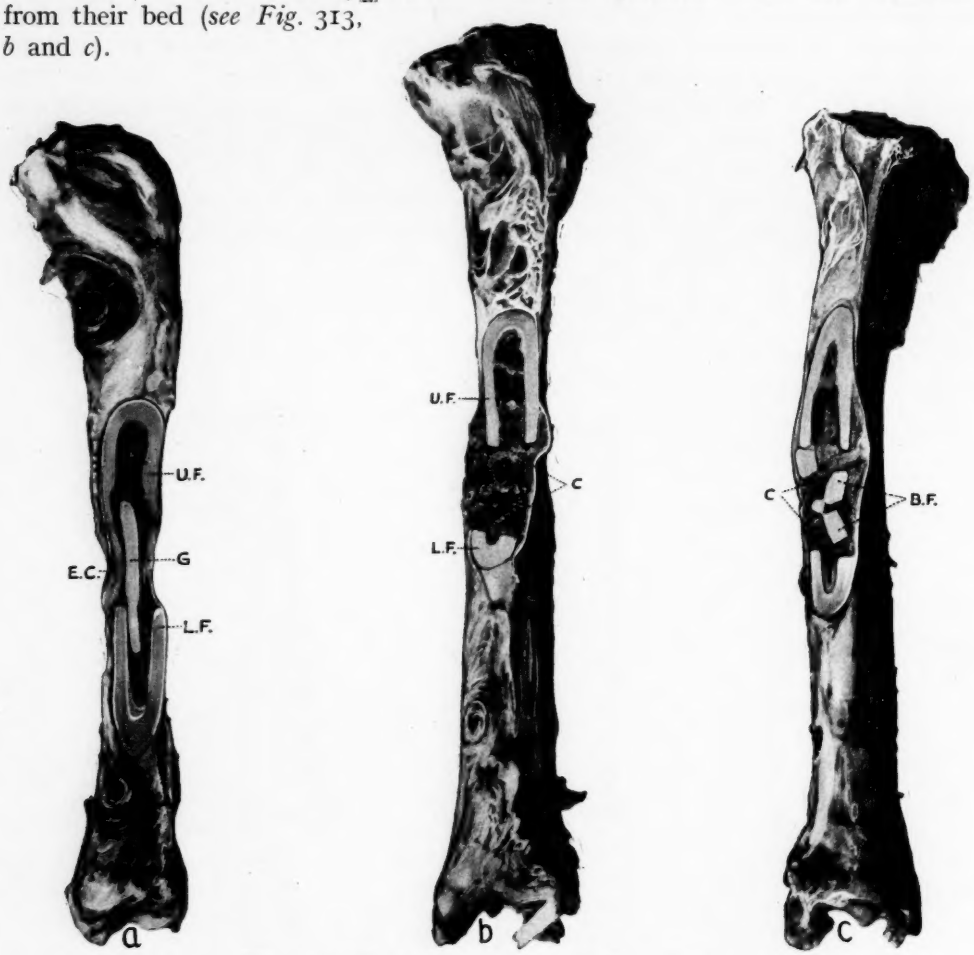


FIG. 326.—SAME SPECIMENS AS IN FIG. 325.

(*a*). No. 86, after 49 days. A graft from the opposite leg lies firmly growing into the ends of the bone and surrounded by a cartilaginous callus. U. F, Upper fragment. L. F, Lower fragment. E. C, External callus. G, Bone graft.

(*b*). No. 88, after 15 days, the grafted bone chips lying embedded in early callus. U. F, Upper fragment. L. F, Lower fragment. C, Callus with loose bone chips.

(*c*). No. 89, after 70 days. Except that the callus is cartilaginous, there is not much advance over the previous specimen, many of the chips being still quite distinct. C, Callus. B F, Bone fragments.

TABLE OF RESULTS AFTER GRAFTING BONE IN A DEFECT.

DATE	No.	PERIOD DAYS	REMARKS
26/6/13	86	49	A single piece of bone used to fill the defect. Solid union
15/7/13	88	15	Gap filled with bone chips. Chips lay embedded in cellular callus
15/7/13	89	70	Gap filled with bone chips. Chips lie in cartilaginous callus, but there is no solid union

SUMMARY.—From these few experiments it appears that a large piece of bone firmly fixed to living bone acts better as a bone graft, than small chips lying loosely.

GENERAL DEDUCTIONS BASED UPON THE ABOVE EXPERIMENTS.

It now remains to examine the series of facts above recorded, as a whole, and to discuss their bearing upon the practical problems of the operative treatment of fractures and the theory of bone repair. The task of applying these deductions to the practice of clinical surgery I propose to take up at an early date, being content here with inferential or occasional references to human fractures.

It seems necessary, however, to point out the chief conditions in which animal fracture experiments fail to represent the conditions found in the human subject. Perhaps the most important of these is the fact that there is no interval between the infliction of the injury and the operation undertaken for its repair. Thus, the overcoming of the contraction of the muscles and the difficult problem of the arrangement of the fragments in a natural position are not dealt with. The use of external splints and bandages is impracticable, and the co-operation of the patient, apart from the mere instinct of resting a painful limb, is not available. The animals, being quadrupeds, can more readily move the limb without bearing weight upon it, than is the case when the leg of a biped is injured.

I was not allowed, by my licence, to break the bones, and therefore the experiments are only concerned with clean-cut bone division, and not the jagged injuries of natural fractures. And lastly, the longest time of observation in any of my experiments was seventy-one days, so that the remote results of the operative treatment cannot be estimated from them.

I.—Factors Determining the Success of Direct Operative Treatment of Closed Fractures.

(*a*). *The Permanent Burying of Foreign Bodies.*—There are many to whom this appeals as the chief factor in the situation. Rather than bury foreign bodies of an unabsorbable nature, they would submit the patient to almost certain anatomical and functional mal-union, or avoid these by methods involving the most tedious delay. Is it possible to determine experimentally whether there is any foundation for these fears of the foreign body in the treatment of fracture? As far as the evidence goes, and for the comparatively short periods of observation, these experiments show that indifferent aseptic foreign bodies do no harm. My justification for this statement is as follows. If a foreign body be harmful, then the more foreign body the greater the harm. But all the experiments with the long steel plates and pins (*see Figs.* 294, 295), and all those with steel intramedullary pegs, in which, relative to the bones, a very large mass of metal was used, were successful anatomically and functionally, and in none was there evidence of injury to the tissues. In all the cases where only a small quantity of foreign body was buried, viz., the short plates, small screws, wire, etc., there was evidence of anatomical and functional failure, and in most of them there was grave tissue inflammation or suppuration. Of course, the good result from the big plates and the bad result from the small, are due to the fact that one is mechanically efficient and the other not, but the fact that the best results were obtained in those cases where the largest foreign bodies were used, is significant of the tolerance of the tissues.

Another circumstance pointing to the same conclusion is, that in many cases when short plates were used, the plate remained firmly fixed to one fragment (*see Figs.* 285, 286, 287, 288) after disunion of the other end had taken place, and after the parts had come to rest. In such cases, if there was always an effort on the part of the tissues to cast off the foreign body, all the screws would certainly be loose after four to six weeks.

(*b*). *Mechanical Efficiency of Fixation.*—This is the most important factor necessary for success. Long plates and perforating pins, or intramedullary pegs of a strong material, gave almost uniform success. Any method of fixation which left a weak and shaky junction was always a failure. Bone has the physical properties of neither wood nor metal. It will not allow a screw to bury its thread in its substance; neither will it maintain for long a thread that has been tapped into its substance if the surface of this thread is subject to continuous tension. Hence it is that any method which depends chiefly upon the bite of a screw into the bone is mechanically inefficient. It is the same principle as that of the tightly-tied ligature in the soft parts, which quickly cuts its way through them until tension is relieved.

It has been widely held that no fixation of the bones in the treatment of fractures is necessary at all. The further assumption has naturally followed, that the object of operative interference will be attained if the minimum of fixation is carried out. A strand of wire, one or two staples, or a short plate and a few screws which for the moment hold the bone ends together, are regarded as doing all that is necessary. This assumption is a fallacy. Healing can only take place when the tissue tension has reached stable equilibrium. If no operation be performed, the parts soon adjust themselves, so that tension is at an end, and in this position union takes place. When a mechanically efficient fixation of the bones has been made, all the muscular force of the limb or the effects of gravity or leverage cannot move them; hence, here again there is nothing to delay healing. But if the bones are tied together by anything which does not hold them firmly and strongly, then movement will constantly take place, and muscular tension will ever be acting upon the healing tissues, instead of being borne by the fixation apparatus.

The relatively great force which fixation apparatus has to withstand is shown very well by the experiments with ivory and bone pegs, in every one of which the peg was snapped across.

To leave the parts alone to adjust themselves by natural laws, or to fix the parts mechanically so that they can withstand all the possible strain that can be put on them, are both reasonable methods; but to tie the parts together loosely or weakly is a fatal compromise which is much worse than either.

Bones left to natural repair will, after finding tension equilibrium, heal by granulation. Bones firmly and accurately fixed will heal by first intention. Bones weakly joined by a method which allows more and more movement between them will not join at all, or their junction will be long delayed.

(*c*). *Sepsis: Its Origin and Significance.*—The attainment of asepsis has quite rightly been laid down as a *sine qua non* in the operative treatment of closed fractures; but the difficulty of its attainment has probably been misunderstood. It has been generally assumed that when metal structures, e.g., plates, screws, or wire, lie at the bottom of a septic sinus, this complication is

due to some technical error, infective material having been implanted in the wound during the operation. But I think there is another explanation of the matter. In the above experiments, exactly the same technique was used in the same place and same circumstances throughout. And yet in one series, e.g., the short plates and screws, or the bone and absorbable pegs, there was a very high proportion of sepsis; whilst in another, e.g., the long plates or the steel pegs, there was not one infected case. This cannot be explained by one group all being done at the same time, because for the most part varied experiments were done on the same day. It seems to me there are three circumstances which conduce to sepsis, quite apart from errors in the aseptic technique of the operation: (1) the mobility of the foreign body used and the bone fragments; (2) the superficial position of the foreign body; and (3) the action of an irritant foreign body upon the tissues. Contrast, for example, the following groups of cases:—

	Number of Experiments	Number of Septic Cases	
Cases where there was much Mobility			
Short plates and screws	9	4	
Bone pegs	7	3	
Spiral wire pegs	6	5	
Total	22	12	more than half
Cases where there was no Mobility			
Long plates and transfixing pegs	5	0	
Steel pegs	7	0	
Total	12	0	none

Then, as to the position of fixing structure. This is much more likely to cause sepsis if it is superficial, e.g., in the tibia rather than when deeply buried in the thigh. Thus, in the above-mentioned twelve septic cases, ten were tibias and only two femurs. The influence of a chemically-irritant foreign body is seen in the action of magnesium. In the pegging operations with this substance there were four septic cases in six operations.

These facts prove that sepsis must depend on something other than errors in the operative aseptic technique. That entire series of operations can be done without a single septic case must be evidence that the technique is good, and when a high proportion of sepsis arises, this is probably post-operative in origin. The mobility of the fragments, together with a loose foreign body, cause a great outpouring of fluid round the fracture. This fluid will soon find its way through the recently sutured wound, and especially so if the loose body lies just underneath the skin (*see Figs.* 285 and 288). The escape of this fluid opens the wound and forms a sinus, which quickly becomes infected from the skin surface. This is a reasonable explanation of the occurrence of sepsis in so large a proportion of cases where there is mobility, a superficial position of the mended bone, or an irritating foreign body. In other words, sepsis is the result of faulty fixation, and not its cause, in the majority of cases.

(*d*). *Delayed Union.*—There is a good deal of clinical evidence that the operative treatment of fractures is accompanied by delay in union. But in this simple problem there are really many factors. Only to mention one of these: probably many cases are treated in such a way that the materials used for fixation, whether screws or wires, become loose in the manner already spoken

of. In such a case repair can hardly begin until the parts have acquired a position of equilibrium, and as the tension of the muscles slowly overcomes the artificial fixation, the bone ends gradually slip over one another until a stable position is assumed. Naturally all this will delay union, and much more so if the process of undoing of the fixation leads to suppuration in the way described in the last section.

All cases should be put aside, therefore, in which fixation was mechanically inefficient, because in these we can never be sure whether a certain result is due to the fixation or to its failure. Of my cases of simple closed fracture with immovable fixation, two series only are suitable for the consideration of this question, those with long plates and transfixing pins, and those with steel intramedullary pegs. In each of these series there is one case in which, after the lapse of a relatively long time, there was no appearance of union. (No. 52, cat's tibia, *Fig.* 295 *d*, 42 days after operation, long plate and split pins. Perfect wound healing and good position and function. No. 50, cat's tibia, steel peg, 42 days, good position, healing by first intention and excellent function). So that in these series, including twelve cases altogether, two show delayed union apart from any other complication. This is positive evidence supporting the contention that operative fixation causes delay in union. It is most difficult to go further than this, and explain why these exceptional cases occur. If it was the absolute fixation preventing the bone ends rubbing upon one another, then it would surely occur more often than once in five times with the long plates and split pins.

Bier and his school have suggested that it is the hæmostasis and the clearing out of blood-clot which in operative treatment of fractures causes delay in union; but in my experiments the fractures were quite fresh, and there were no blood-vessels tied or constricting bandages applied, so that there must always have been blood surrounding the fracture.

The most probable explanation that occurs to me is the mere interference with the blood-supply of the fractured bone ends. In the shaft of a long bone there are three sets of vessels: those in the periosteum, medulla, and the Haversian canal system. When any operation is performed on these parts, there is the probability that the periosteum is raised from the bone, which will temporarily divert the first set; and if the marrow cavity is extensively bored, then the second set will also be more or less destroyed. Thus there will be left only the third, that is, the small vessels in the dense bone itself. It is easy to understand that under these circumstances the blood-supply will be so poor that there will be a delay in healing. In both the specimens I have referred to this explanation would be satisfactory. The bone ends are perfectly healthy, but merely indolent.

There then arises the further question as to the ultimate result of this delayed union. If the bones are firmly fixed by prostheses which actually take the place of either internal or external callus, the result from a practical point of view is negligible. That is to say, the function of the limb is just as good in every way as if union of the bones had occurred, and in a further period of time the indolent bone ends will grow together. This line of argument supplies another reason for making the union mechanically firm, and of such a character that it will support the bone in good position for an indefinite time.

(*e*). *Comparison of Periosteal and Intramedullary Methods of Fixation.*—For this purpose, we have again the same two series of cases for consideration, viz., those in which long plates with transfixing pins, and those in which steel intramedullary pegs, were used. Practically, these two groups have both given the same results—a firm lasting fixation, good union in the majority of cases, an absence of sepsis, and uniformly good function. In both there has been one case of delayed union.

The advantages of the long plates with transfixion are, that their application interferes but little with the marrow cavity, and that they can be removed if necessary without disturbing the bone union. On the other hand, they are more difficult to apply accurately if there is much displacement of the bone, and they require a long incision, with an exposure of the bone on two opposite sides.

The advantages of the pegs are, that with the proper instruments they are easier to apply than plates, and will require only a small incision; they will, when applied, automatically ensure the correct alignment of the bone. But for general use there are many drawbacks. They require an extensive sacrifice of the medullary cavity, and a large series of different-sized pegs and borers; they cannot be used if the bone is at all splintered or comminuted; and they cannot be removed without danger of re-fracturing the bone.

II.—On the Indirect Methods of Fixing the Bones.

In my experiments these have only been represented by the double transfixion apparatus. By the use of this I have obtained better results than with any method of direct operative attack upon the area of fracture. That is to say, in every case there was rapid union, perfect function, and absence of sepsis (apart from cases where plates were also inserted), and further, the method is as readily applicable to comminuted and open, as to simple and closed, fractures.

I think my experiments bear this out so amply that I need spend no more words in enforcing it, beyond pointing out that the method is much easier of application than any other. In fact, it only constitutes a minor surgical proceeding, which can be carried out in a few minutes with a very simple technique and the minimum of risk of sepsis.

The question of real moment about this method is, how far the experimental conditions are representative of those occurring in actual fractures. In the experiment, the transfixing rods are applied before the bone is divided, and thus anatomical accuracy ensured. This is the crux of the whole matter. Any method which lays hold of the two bone ends in such a way as to restore good anatomical position and maintain it until union has occurred, without interfering with the function of the joints and muscles, may be regarded as fulfilling the conditions of these experiments, and may be expected to give equally good results. In some cases, simple extension by weights, springs, or screws, applied by apparatus which acts only through the unbroken skin, will do this. In others, some sort of transfixion of the bone ends will be necessary, in order both to overcome the muscle tension, and to maintain this without immobilizing the limb. But in many cases, any of these methods will fail in attaining the experimental conditions, either because they do not accurately reduce the fractured ends, or because they fail to retain the broken bone firmly, or because in doing these things they require the long immobilization of the muscles and joints.

III.—The Treatment of Comminuted Fractures.

The success of the indirect fixation of the fracture is nowhere seen to greater advantage than in the comminuted cases. In the experiments I have related, the bones were not merely divided into several parts, but they were crushed so as to be reduced to many small pieces. In any given case where there are only a few large fragments, these may of course be united severally to one another and to the main parts of the bone. But the cardinal principle of mechanically efficient fixation will be in danger of violation in direct proportion to the complexity of the fracture. On the other hand, by securing the main fragments in correct position and fixing them to one another, and by leaving the small fragments as little disturbed as possible, the best possible result may be obtained. This principle can be carried out either by the transfixion rods with outside connecting-bars, or else by long plates applied on each side of the bone, bridging the comminuted portion, and connected to one another by bolts which pierce the whole thickness of the shaft.

To ensure rapid and strong union, every fragment is to be left in position, quite regardless of whether it has a periosteal attachment or not. But in cases where the strength of the bone is not of such importance as the mobility of a neighbouring joint, it is wise to remove some of the loose fragments of bone in order to avoid callus excess. If any part of the bone is removed, then broken up and put back in place, these ill-fitting bone chips are apt to take on osteogenetic function very slowly (*see Figs.* 325 and 326 *b* and *c*) and therefore even the temporary removal of pieces of bone and a return of these in a disorderly manner is to be deprecated. The reason for this will be alluded to in a later section.

IV.—The Treatment of Open Fractures.

In the strict sense of the word all my cases were open fractures; but in the ordinary clinical sense none of them were such, except those where the wound broke open subsequent to the operation. Open fractures in the usual sense of the term must all be regarded as septic; but practically they are divisible into those where the infection is so trivial that no serious delay is occasioned by the wound, which quickly closes and then allows operative treatment to be carried out, and those where the infection is of a serious character, dominating the case.

My experiments have no practical bearing on the latter group; but as regards the former, which are much the most numerous, they give some useful suggestions. In such cases, clearly some indirect method of fixation should always be adopted without delay. In many this will be all that is necessary, and in others it will suffice to minimize displacement until the wound has healed and direct operative attack can be undertaken. What I have written in the last sections about the indirect method of bone fixation, applies with great force to these cases of open fracture, and there is this fact in addition: with the transfixion or other similar apparatus, the wound can be dressed without disturbing the fracture, and owing to the whole of the surface of the limb being left uncovered, any extension of septic mischief can be detected and dealt with as it arises.

ON THE REGENERATION OF BONE AND THE THEORIES OF CALLUS FORMATION.

It would require a large treatise to discuss adequately all that has been done and written on this subject, and I propose to content myself with a very brief statement of some of the main matters of dispute, pointing out the bearing that the facts of my experiments have upon them. For the reasons both of brevity and simplicity, I have referred but little to microscopical appearance, for although parts of the bones from all the important specimens have been decalcified, embedded in paraffin, and cut in serial sections, the description of these would take me far beyond the scope and purpose of this article.

The Parts played by Periosteum, Medulla, and Dense Bone in the Process of Regeneration and Repair.—The teaching on this subject, of which Ollier has been the most distinguished author, and which has dominated the conceptions of surgeons, pathologists, and students, has been that the periosteum is the all-important factor in bone growth. It has been proved by Ollier and many others that the separated periosteum can and does reproduce bone under certain conditions, particularly in young subjects and when the periosteum is left partly attached to its original bed. There is a negative side to this evidence which has been rather overlooked, the practical importance of which, however, is very great; that is to say, many, in fact the majority of experiments of transplanting periosteum have had no result. These have been assumed to be due to some technical error or experimental accident, and the positive results have been held to outweigh the negative. The fact that periosteum can, and does, reproduce bone sometimes, being taken as proved, many experiments have been cited in which all new bone formation connected with the periosteum has been regarded as derived from the latter. For example, the well-known silver ring experiment, in which a metal band laid round a bone under the periosteum is covered over in time by new bone between the metal and the periosteum. The fallacy of this deduction lies in the fact that in this, and in all similar experiments, it is obvious that the new bone may be derived from the old bone, and merely grow thence under the periosteal envelope. Macewen's experiments have, on the other hand, proved that the living bone is the main origin both of regeneration and repair, and that these can take place in the absence of the periosteum. He entirely denies the osteogenic faculty of the periosteum, and points out that whereas bone growth is only occasional and exceptional from periosteum completely separated from the underlying bone, on the other hand, bone growth from living bone deprived of its periosteum is regular and constant. It is evident, as I have said, that in the examination of fractured bones, apart from special devices to separate the periosteum from the bone, it is impossible to be certain whether a given mass of external callus is derived from the periosteum which is on one side, or the bone which is on the other (see for example the specimens in *Fig.* 308), and it is rather astonishing that so many observers have attributed the origin of external callus to the overlying periosteum, without considering that it may equally well have grown out from the underlying bone. But even with such simple specimens of external callus, the appearances support much rather the osseous than the periosteal origin

of callus. *Fig.* 327 gives a good illustration of this; and the specimens shown in *Figs.* 289, 291, and 302 *a* go a step further, for in all these it is seen, even with the naked eye, that the callus is formed both of bone and cartilage. The process of repair consists in the cartilage being converted into bone,

FIG. 327.—CAT'S TIBIA (No. 5), THE WHOLE SPECIMEN BEING SHOWN IN FIG. 300 *a*, 17 DAYS AFTER OPERATION.

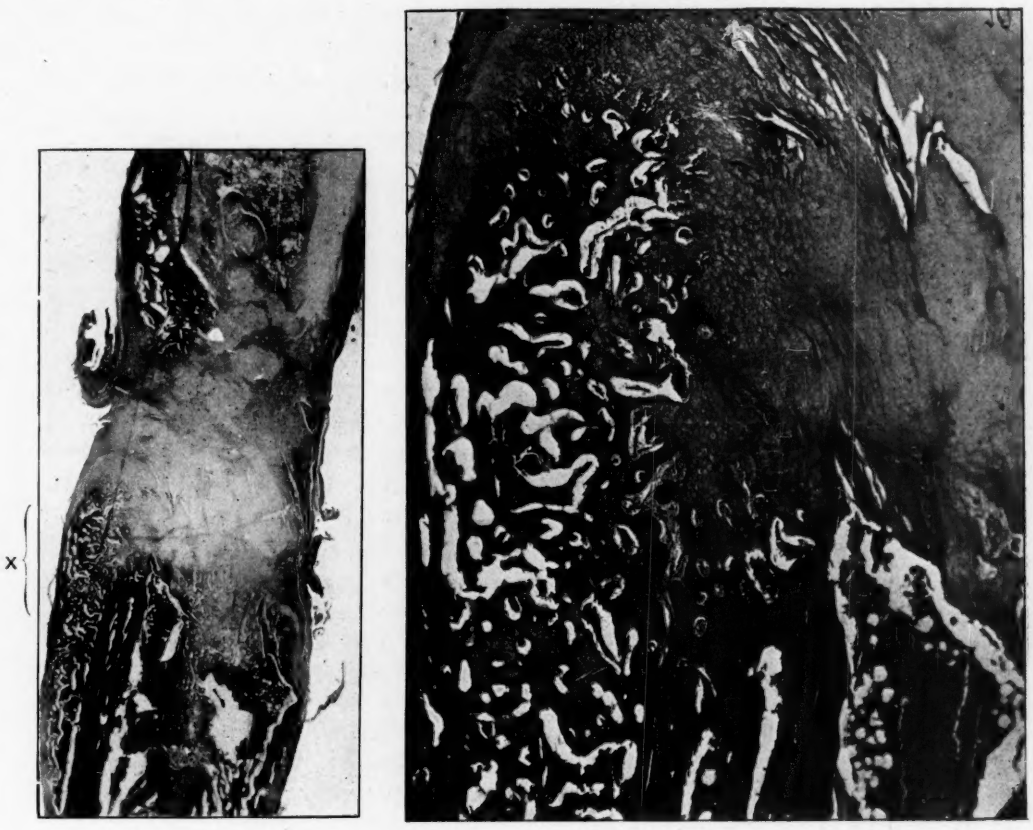
Longitudinal section of the dense bone, with the overlying external callus, as seen under a ½-in. objective.

B, Dense bone of the shaft. **S**, Space between the callus and the dense bone artificially produced in the cutting of the section. **O.C.**, Deep layer of ossified callus. **C.C.**, Outer layer of cartilaginous callus. **P**, Periosteum fused with overlying connective tissue.

There can be no doubt that this thick layer of external callus is growing in direct continuity with the bone, and the ossification proceeding from the bone. The way in which the callus breaks from the bone in the process of cutting the section, although purely accidental, is nevertheless very instructive, because it marks the line of most ready cleavage, between two layers of tissue of different density. When necrosis occurs, it is in this line of cleavage that the inflammatory products accumulate and separate the outer involucrum from the inner sequestrum. But nevertheless, the involucrum has grown from the bone.

and this process of ossification can be seen to proceed from the surface of the bone outwards towards the periosteum, and not in the reverse direction. When the periosteum has been excluded by the use of encircling metal

plates, the formation of callus by the bone itself is demonstrated to take place without fail. In *Fig.* 298 *a* the bone is seen after ten days, rough and pitted by granulation tissue, which is the first stage of callus; in *Fig.* 298 *b* the external callus is well advanced. In *Fig.* 299, after fifty-two days, the bones are seen to be united by a thin layer of external callus, the amount of which has been limited by the steel plate, and a thin transverse disc of cartilage at the line of fracture. The interior of the bone is occupied by a large mass of internal callus; this can only



A *B*

FIG. 328.—No. 70, THE SAME SPECIMEN AS SHOWN IN FIG. 314 *b*. AFTER 42 DAYS. LONGITUDINAL SECTION.

A.—Magnification by ½-in. objective. X is the portion of bone shown in *B*. At the upper and lower parts are seen the ends of the bone, and between them the new callus. This is cartilaginous in the centre, but from the bones osseous tissue is growing into it.

B.—Magnification by ¼-in. objective. The direct structural continuity between the bone and the ossified callus is seen.

have originated from the marrow cavity and from the dense bone, which has almost disappeared in giving rise to this new tissue. *Figs.* 317 *a* and *b* show the same thing in comminuted fractures.

In the next place, we have a series of cases where a piece of bone has been removed from the shaft, leaving the periosteum in its place. Some of these were comminuted fractures, and in others a piece of bone was

cleanly cut out. In the former there was a uniform filling up of the gap by callus of a very immature character. In the latter there was no callus formation except at the ends of the cut bone. In all these cases the space left is bounded both by the sleeve of periosteum and by the cut or broken bone ends, and therefore either of these structures may take part in filling it. *Figs.* 314 and 315 show the crushed bones. In all four specimens the gap is filled with callus; in *Figs.* 314 *a*, 314 *b*, and 315 *a*, there is more, or more advanced, callus next to the bones than in the centre—evidence that these bones have produced the callus. In *Fig.* 314 *a* the central point is merely fibrous, whereas at either end it is ossified. In *Fig.* 314 *b* the central part is cartilage, whilst the part in contact with the bones is bony. This is seen in greater detail in the sections shown in *Fig.* 328, *A* and *B*.

Figs. 319 *a* and *b* and 320 (specimens 80 and 79), show the result of cutting out a part of the bone and leaving the periosteum. There is a complete absence of any callus in the greater part of the gap left. *Fig.* 319 *a* (80) shows a cap of callus upon the cut bone end, sharply limited, and looking as if it was unlikely to have spread much further if the animal had been left alive. The only difference between these cases and those of the comminuted fractures was, that in one case the bone was clean-cut and in the other crushed. The periosteum was similarly treated in both. The crushed bones, having a larger broken surface, exude more callus, and the cut bones less, and in none of these particular specimens is there any evidence of the periosteum taking any important part in the regeneration of bone. In two cases, not only was a part of the bone removed, but the cut bone ends were covered by rubber tissue in order to exclude them from a share in the formation of any tissue that filled the gap. In one (No. 84) there was nothing in the gap; but in the other (No. 85), shown in *Figs.* 319 *c* and 321, there was quite good callus formation. Such a specimen as this, taken by itself, might be put forward as a convincing demonstration that the periosteum, and periosteum only, is the source and origin of callus; but taken in conjunction with all the other evidence in this paper, it is merely an example of the fact, incontestably proved by Ollier and others, that under certain conditions the periosteum can and does reproduce bone. It in no way shakes the evidence that, under usual conditions, new bone and bone repair originate by proliferation from bone tissue, in which process the periosteum plays quite a secondary part.

Between the fibrous periosteum and the bone there lies a layer of cells which are nothing more or less than a layer of osteoblasts. If, in separating the periosteum from the bone, this layer of osteoblasts be taken with it, as will usually be the case in young bones or after inflammatory changes have occurred (*see Fig.* 327) when the layer is thick, then the separate periosteum has osteogenetic power in virtue of the bone layer which adheres to it. But the removal of this osteoblast layer with the periosteum is more or less accidental, and hence the great uncertainty of reproducing bone by a transplantation of periosteum. On the other hand, the bone itself is full of osteoblasts, and when any portion of it is removed without interfering with its vitality, it will always be capable of reproducing new bone. If the term periosteum were applied, as it ought to be, simply to the fibro-elastic tissue layer, then it may be held that this is nothing more than a limiting membrane without any osteogenetic power.

But if by periosteum is meant the fibrous layer with the bone-cells adhering to its deep surface, then it has osteogenetic power just in proportion as it takes with it this part of the living bone. The observation has often been made, but its significance in this connection rather overlooked, that whatever doubt and uncertainty there may be as to whether the periosteum can and does reproduce bone, there is no doubt whatever that the bone can and does always reproduce periosteum when a part of the membrane has been removed from its surface. If then the bone is certainly the mother of the periosteum, it is very unlikely that the periosteum is also the mother of the bone.

The Amount, Position, and Constitution of Callus.—Callus, as the chief material of bone repair, is laid down in an amount which differs according to certain well-defined conditions. In the case of the soft tissues, the healing of a wound is said to be by first intention when the severed tissues seem to grow directly together with the minimum of cementing new tissue, or by granulation where there is a large gap to be filled and the original tissues are eventually united by a large mass of scar tissue. So it is with broken bones. When the fractured surfaces are placed in accurate apposition and firmly held in that position, as seen in *Figs.* 295 *a* and *c*, 307 *a* and *e*, 311 *b*, 312 *a b* and *c*, there is the very minimum of reparative callus, and a direct continuity of the bones is re-established. This is shown in microscopical section in *Fig* 329. A consideration of my experiments makes it difficult to believe that any such result could be obtained in complete fractures, when the bone ends are not accurately apposed, or when they are allowed free movement. On the other hand, there is a great callus excess produced by mal-position and mobility (*Figs.* 285, 287, 289, 290, 291, 302 *a*), or by a degree of mobility without mal-position (*Figs.* 307 *b*, 308 *a* and *b*), or by any condition of tissue irritation (*Figs.* 305 *a* and *b*, 308 *a* and *b*), or by great fragmentation of the bone (*Figs.* 307 *c*, 313 *b* and *c*). These facts are so generally conceded that it is not necessary to do more than illustrate them by the examples given.

FIG. 329.—Longitudinal section of the site of fracture in No. 53; ½-in objective. The same specimen as that shown in Fig. 295 *c*, after 42 days. The section passes through the side of the bone, the marrow cavity not being fully shown. Note the great thickening of the dense bone and its great canalization. The fracture is seen to be merely a linear irregularity, and there is practically no callus.

The opposite extreme, the failure of callus formation, with consequently delayed union, is seen in *Figs.* 295 *d*, 302 *b*, and specimen 52 (not illustrated), and I have discussed the explanation of this phenomenon in connection with the factors relating to operative treatment above. I would merely repeat here that this seems to be due to an interference with the blood-supply of the bone ends by a simultaneous interference with the periosteum and medulla. Such specimens

A

B

FIG. 330.—SECTIONS SHOWING THE RELATION OF CARTILAGINOUS AND BONY CALLUS. ½-IN. OBJECTIVE.

A.—No. 48, the specimen shown in Fig. 294 *b*, after 34 days. The section is longitudinal, and passes tangential to the dense bone, through the external callus. The cartilage zone is opposite the line of fracture.

B.—No. 44, the specimen shown in Fig. 307 *b*, after 42 days. Two longitudinal sections through the external callus, showing the cartilage remaining at the line of fracture (right-hand section) and beneath the periosteum (left-hand section).

as that in *Fig.* 302 *b*, and others in the same series, are susceptible of a further explanation. An oblique fracture is surrounded by several turns of wire. This is not enough to hold the bones rigid, and there must therefore be a tendency to the mechanical destruction by the chafing wire of external callus exuding from the bones.

The formation of a false joint, illustrated by *Figs.* 292, 293, 301 *a*, and 301 *b*, in my experiments has always been associated with great displacement of the fragments and unrestrained mobility. In the specimens figured in 292 and 293 there is little or no callus, but in *Figs.* 301 *a* and *b* are seen cases where the pseudarthrosis co-exists with callus excess.

The occurrence of cartilage in callus is a matter which has given rise to much discussion. That it is a constant feature of the repair of animal fractures has always been recognized. It is present in relatively large amounts when the callus mass itself is great, i.e., when displacement and mobility co-exist. This is well illustrated in *Fig.* 302 *a*. It persists longer and in greater amount at the line of fracture and under the periosteum than elsewhere, and this is well shown in *Figs.* 289, 291, 295 *b*, 298 *b*. 302 *a*, and 307 *b*, and in microscopical sections in *Fig.* 330. It is usually absent, or present only in microscopical amount, when union is complete and when union has taken place in good position with fixation, and this is

illustrated by *Figs.* 295 *a*, 295 *c*, 311 *b*, 312 *b*, and 312 *c*. All my specimens seem to show that there is a direct conversion of osteoblasts into cartilage cells, and of cartilage cells into osteoblasts. The generally accepted statement that cartilage is not a constituent of human callus is probably incorrect, and due to the fact that the specimens on which the statement is founded were of an age when the cartilage has disappeared. Many observers who have studied early cases of human fracture have found that cartilage is abundantly present. Amongst these are Duhamel, Maas, Flourens, Hofmokel, Dupuytren, and Orth (quoted by Zondek). Ziegler gives details of a human complicated fracture above the ankle, eight weeks old, in which there was abundant cartilage, and he states that he has found it in over fifty human fractures; and as recently as December 6, 1913, Morley, in the *British Medical Journal*, has described and figured luxuriant cartilage growth as resulting from a periosteal injury in a human femur.

On the Behaviour of Isolated Bone Fragments.—This subject, trending as it does on the large field of the transplantation of bone, is so difficult, and my experiments are so few, that I wish to speak with some reservation, realizing the dangers of drawing far-reaching conclusions from insufficient data.

I have three groups of experiments which bear upon this point.

The first deals with comminuted fracture, and is illustrated in *Fig.* 313 and the microphotos, *Figs.* 331 *A* and *B*. In these, and particularly in *Figs.* 313 *b* and *c* and *Fig.* 331, it is seen that every isolated piece of bone acts as a centre of active bone proliferation, and forms a firm mass of ossified callus. Seeing what rapid callus formation occurred around these fragments in comminuted fractures, I thought it would be easy to demonstrate that bone-grafting would take place much more readily from bone chips than from large fragments of transplanted bone. But, unless the remaining groups of experiments are for some reason fallacious and exceptional, this is proved to be incorrect.

The second set of experiments dealing with isolated bone chips is illustrated in *Figs.* 325 *b* and *c*, 326 *b* and *c*, representing two cases. In both these a part of the tibia was removed, crushed into as small fragments as possible, and then these pieces were returned to the trough of periosteum, the bone being put up in the transfixion apparatus; but at the end of fourteen and seventy days, it is seen that the majority of these bone chips still remain isolated and inactive. When the specimens were cut with a fine fret-saw, many of the chips fell out, instead of remaining firmly embedded in callus, as in the case of the comminuted fractures. It is not worth discussing these at length, for they may be exceptional cases, but I would venture to put forward a possible explanation. In the case of the comminuted fractures, the bone fragments were left fitting together with but little space between; hence their blood-supply is not completely isolated, and new blood-vessels readily grow across from one fragment to another. When the piece of bone is removed and broken up, and the bits are put back in a disorderly fashion, there are relatively large spaces between the bones, filled up with blood-clot. This clot has first to be vascularized before the bone chips can get a sufficient blood-supply to provide for new growth.

The third group of experiments is illustrated in *Figs.* 325 *a* and 326 *a*. In this case a long splinter of bone was taken from the opposite tibia, and its ends

A

B

were placed tightly in the medullary cavities of the bones above and below a gap made by taking out a piece of the bone. There is good vital union between the bone ends and the graft, and the graft itself is the centre of new callus formation.

These experiments appear to prove, therefore, that isolated bone fragments can and do act as centres of new bone growth, but that for this to take place most effectively, the fragment must be placed in close apposition to neighbouring living vascular bone.

SUMMARY OF CONCLUSIONS.

1. That the most rapid and perfect method of fracture repair follows "indirect fixation," namely, fixation which does not directly interfere with the area of fracture.

2. That for such perfect results to be obtained by "indirect fixation," it is necessary for the method to ensure (*a*) perfect anatomical restoration, (*b*) fixation for the period required by union, and (*c*) perfect freedom of all the soft parts and joints, so that the limb can be used directly pain has ceased.

FIG. 331.—LONGITUDINAL SECTIONS FROM No. 72, THE SPECIMEN OF COMMINUTED FRACTURE SHOWN IN FIG. 313 *b*, AFTER 28 DAYS.

A. Magnification by ½-in. objective. The fragments of the original bone are seen to be the centre of new bone growth.

B. Magnification by ¼-in. objective of the portion of *A* marked X. In the upper part of the section is seen a bone fragment in active growth, and lower down is a large area of cartilaginous callus.

3. That in all complete fractures there exists a very strong force which tends to displace the fragments until the muscles are thrown out of action and a position of stability free from tension is acquired. This involves great deformity, consisting of shortening, overlapping, and angulation.

4. The operative treatment of fractures should aim at completely counteracting this displacing force. It should not only accurately replace the fragments, but do so in a manner of such mechanical efficiency that displacement cannot occur.

5. The mere presence of an aseptic indifferent foreign body in the tissues has no ill effect upon healing tissues, unless there is an interposition of its substance between structures which ought to unite.

6. That the frictional grip between a bone and a screw will rapidly give way if subjected to much tension, owing to the absorption of the bone.

7. That the union of bones by plates and short screws is mechanically inefficient, because the screws are quickly pulled out of the bones.

8. Sepsis is often the result, and not the cause, of inefficient mechanical fixation.

9. Mechanical efficiency in the direct operative treatment of fractures can be attained in two ways: (*a*) By the use of long plates and pins or bolts which transfix and hold the bone by some broad flange or nut; and (*b*) Strong, solid intramedullary pegs.

10. Perfect anatomical union and normal function usually result from either of the above methods. Normal, sound, and rapid repair is perfectly consistent with absolute rigidity.

11. Delay in union is a possible, though exceptional, result of perfect operative fixation of a fracture. It is due probably to interference with the blood-supply of the bone ends, and will cause no disadvantage if the mechanical fixation be so efficient as to hold the bones in good position for an indefinite time.

12. The fixation of transverse or slightly oblique fractures by encircling wire is unsatisfactory, because it is mechanically inefficient, and allows from the outset a mobility which delays union by interfering with the zone of repair.

13. All forms of absorbable pegs that I have tried are unsatisfactory, because they either break or bend before good union has occurred.

14. Metallic magnesium, when used as a peg, acts as a powerful stimulus to callus formation.

15. The natural position assumed by bones which are not fixed, results in deformity, callus excess, or the formation of a false joint.

16. In the treatment of severely comminuted fractures, and in certain cases of open fracture, the best method of treatment is by a fixation of the main fragments, leaving the small pieces in position when strength of union is the chief object, and removing some of them when callus excess is likely to interfere with the mobility of a joint.

17. In the repair of bone defects: (*a*) Natural repair occurs rapidly when only part of the thickness of the bone is destroyed; (*b*) Fragments of bone used as a graft (from the same animal) form new bone very slowly if they are only loosely inserted in the gap; (*c*) Large pieces of bone used as a graft unite quickly, and form the centre of new bone growth, if they are tightly fixed to the raw surfaces of vascular bone.

18. The periosteum is the product, and not the mother, of bone. All the osteogenetic properties of the periosteum, whether in the repair of fractures or in grafting, are due to the more or less accidental presence of the outer layer of bone-cells adherent to its deep surface.

19. Living bone is the chief source and origin of callus, which grows mainly from its outer or periosteal surface, and to a less extent from its deep or medullary surface and its cut ends.

20. Cartilage is a constant stage in the transformation of bone-granulation tissue into bone. It is present chiefly (*a*) in early stages of repair, and (*b*) when there is much displacement and mobility; and it remains longest under the periosteum and at the line of fracture.

[The experimental part of this investigation was carried out in the research department of the Medical School of University College Hospital, London, and the pathological part in the laboratory of the General Hospital, Bristol. My most cordial thanks are due to Dr. Bolton and Dr. Scott Williamson as the respective directors of these two laboratories for their kindness and assistance, and also to the Scientific Grants Committee of the British Medical Association, who have defrayed a large part of the expenses of the work.]

REFERENCES.

1. *Works of cardinal importance which contain new observations with summaries of, and references to, other cognate papers:—*

OLLIER, Traité experimental et clinique de la régénération des os, et de la production artificielle du tissu osseux. Two volumes. Paris, 1867. This contains a full historical account, with references up to date.

STREISSLER, Der gegenwärtige Stand unserer klinische Erfahrungen über die Transplantation lebenden menschlichen Knochens. *Bruns' Beitr. z. klin. Chir.*, Tübingen, 1911, vol. 71, 1. This contains a complete list of references about bone transplantation up to 1909.

AXHAUSEN, Histologische Untersuchungenüber Knochentransplantation am. Menschen. *Deut. Zeit. f. Chir.*, Bd. xci, 388. (Other references given in last-named paper.)

BARTH, Untersuchungen über Knochenimplantation. *Zeigler's Beitr.*, 1895, Bd. xvii, s. 65. Also *Berl. klin. Woch.*, 1896, 8, and *Archiv. f. klin. Chir.*, 1897, Bd., liv, 471, and other papers mentioned by Streissler.

MACEWEN, The Growth of Bone. Published by Maclehose, Glasgow, 1912.

SCHMIDT, *Allgem. Pathologie u. pathol. Anatomie der Knochen.* Lubarsch-ostertag Ergebnisse. Vols. iv, 1897 and v, 1898. (Contains exhaustive literature on the subject of callus formation.)

2. *Works relating chiefly to experimental or animal fractures—dealing principally with callus formation:—*

BIDDER, Zur Frage über d. Herkunft des sog. irneren Callus. *Centralb. f. Chir.*, 1876, Bd. iii, 657.

BORST UND RIEDINGER, Sitzungsberichte d. phys.-med. Ges. zu Würsburg., 1908, 63.

BUCHHOLZ, *Arch. f. Pathologie*, Virchow, 1863, xxvi, 78.

BUSCH, Exp. Untersuch. ü. Osteitis u. Nekrose. *Arch. f. klin. Chir.*, 1877, Bd. xx, 237.

FOA, *Gior. d. m. Accad. de med. di Torino*, 1903, lxvi, 582.

HAAS, Regeneration of Bone from Periosteum. *Proc. Soc. Exp. Biol. and Med.*, New York, 1913, xiii, 57.

HAAB, Untersuch. aus d. Path. Inst. z. Zurich, 1875 Hft. 3, 25.

HANAU, Exp. Untersuch. über Callusbildung. *Verhandl. d. Gesellsch deutsch. Naturf. u. Aerzt.*, 1897, lxviii.

HERZ, *Deut. Zeit. f. Chir.*, 1901, lx, 398.

HILTY, Der innere Callus, seine Entstehung u. Bedentung. *Zeit. f. rationelle Med.*, 1853, Bd. iii, No. 7.

KÖNIG, *Münch. med. Woch.*, 1913, lx, 439.

MERLANI, Ricerche sperimentale sulla prod. di cartilagone nel processo di guarigione della fratture. *Policlinico*, Rome, 1910, xvii, sez. prat. 355.

MATSUSKA, *Deut. Zeit. f. Chir.* 1903–4, lxx, 13.

MAAS, Wachstum, Regeneration, u. Callusbildung d. Rohrenknochen. *Arch. f. klin. Chir.* 1877, Bd. xx, 708.
ROST, Exp. u. klin. Untersuch. über chronische Entzundungen des Knochenmarks, *Deut. Zeit. f. Chir.*, Oct. 1913, 83.
RIGAL ET VIGNAL, Recherches exp. s. l. formation du cal, etc. Ecole prat. d. hautes études. Lab d'histol. du Coll. de France. *Trav.*, Paris, 1881, vi, 107.
SORRENTINO, Ricerche sperimentale sulla formazione del callo osseo, *Arte Med.* Napoli, 1900, ii, 804.
ZIEGLER, *Deut. Zeit. f. Chir.*, 1901, lx. 201.
ZONDEK, Zur Transformation des Knochen Callus Experimentelle Untersuch u. ihre klin. Bedentung. Hirschwald, Berlin, 1910.

3. *Influence of nervous system on the healing of fracture* :—

ARCOLO, *Riforma med.* Palermo, 1900, i, 519.
MUSCATELLO U. DAMESCELLI, *Arch. f. klin. Chir.*, 1899, lviii, 937.

4. *Experimental observations, etc., in relation to treatment* :—

LUCAS-CHAMPIONNIÈRE. Traitement des fractures sans immobilisation chez le chien, *Jour. de Med. et Chir. Prat.*, 1888. lix, 65. (This is only a short note about some dog fractures, with no dissections or illustrations).
ROSSI, Exp. Beitrag z. Frage der Behandlung v. Knochenfracturen. *Allg. Wien. Med. Ztg.*, 1901, xlvi, 27. *Klin. Therap. Woch.* Wien. 1900, vii, 1637. *Clin. Chir.*, Milano, 1901, ix, 6. *Arch. di Ortop.* Milano, 1901, xvii, 369.
RONCALI, Contributo allo studio delle infezioni consecutive alle fratture esposte sperimentale, Policlin. Rome, 1895, ii, 383, 439, 514, 555.
POTÂRCHÀ, Certetari experimentale a supra protesei metalice superiostale in tratamentul imediat al unor fracturi osóse. Spitalul, Bucuresi, 1895, 457, 481.

5. *Experiments in relation to congestion or the application of fibrin or blood-clot to fractures*—

BERGEL, Callusbildung d. Fibrin. *Arch. f. klin. Chir.*, 1910, xciii, 755.
BUM, Experimentelle Untersuchungen über den Einfluss der Stauung auf die Entwicklung des Knochencallus. *Centralb. f. Chir.*, Leipzig, 1901, xxviii, 1153.
FORLINI, Contributo Sperimentale agli effetti dell' iperemia da stasi nella guarigione delle fratture. *Clin Vet.*, Milano, 1909, xxxii, sez. sc. 78.
POCHHAUMER, Uber parosteal Callusbildung, etc. *Deut. med. Woch.*, 1910, xxvi, 2120, and *Archiv. f. klin. Chir.*, 1911, xciv, 352.
SCHMIEDEN, Experimentelle Studie z. Bier's Behandlung d. Pseudoarthosen Mittels Bluteinspritzung. Sitzungshericht d. Niederrhein Ges. f. Natur. u. Heilkunde z. Bonn. Oct. 1904, and *Med. Klin.*, 1907, 197.

A BRIEF ACCOUNT OF AMERICAN SURGERY DURING THE PAST TWELVE MONTHS.

By GEORGE W. CRILE, Cleveland, Ohio, U.S.A.

GENERAL SURGERY, INFECTIONS, ANÆSTHESIA, SHOCK.

Estes[1] gives a *study of 724 major amputations*. The mortality for single major amputations is a little better than before the present series—4·30 per cent (former 4·76). This is but small improvement. We have to consider continually saving of blood, asepsis and antisepsis, and carefully discriminate when to operate. The blood-pressure is a valuable guide. Systolic pressure below 80, contraindicates. The author's material is of a somewhat special character, owing to the proximity of great steel mills, mines, etc. There are not a few cases of double major synchronous amputations (mortality 23·68). The author adheres to the old classical amputations, making little attempt to devise new ones.

Beckman[2] writes about the *complications following operations*. He gives figures from the Mayo clinic—5835 indoor patients. These are summed up under infections, pulmonary complications, thrombophlebitis, rashes, epididymo-orchitis, acute dilatation of the stomach. There were 111 cases of infection, the rationale of which was for the most part unknown. Certain factors were, introduction of the hand through a too small opening, and escape of secretions into the peritoneal cavity. The great majority of these infections were peritoneal. There were 80 cases of pulmonary complications, not counting embolism, of which there were 3. The 80 cases were divided among pleurisies, bronchitides, bronchopneumonias, and lobar pneumonias, bronchitis being the most frequent. There was no palpable connection between the operation and the pulmonary complication. The greatest number of bronchitis cases followed posterior gastroenterostomy, and next in frequency appendicectomy and inguinal hernia; the greatest number of pleurisies followed appendicectomy, etc. There were 16 cases of thrombophlebitis, chiefly on the left side. In a larger series of operations—8,703—there were 119 deaths—between 1 and 2 per cent.

Ashhurst and John[3] attempt to bring together the various methods in the *rational treatment of tetanus*. The authors believe that an intensive and synergistic treatment begun very early in the case would reduce the mortality to 20 per cent. Antitoxin should be injected by all the routes—intraspinal, intracerebral, intraneural, intramuscular, intravenous, and subcutaneous, and the doses should be comparatively frequent and large. Phenol injections may be superadded, and perhaps cholesterin and magnesium sulphate, as well as the usual depressants. The author's mortality of 56·5 per cent up to 1912 is about the average of recent reports. Since that period, and under the above management, seven out of eleven cases have been saved (36·36 per cent mortality). Three other authors quoted have saved two cases out of three. In many series of cases, the mortality is from 65 to 85 per cent.

Robinson[4] has collected a large number of cases of *intratracheal ether anæsthesia*. The author, originally connected with the Massachusetts General Hospital, has records of this form of anæsthesia in 1400 cases (22 clinics). His conclusions are brief: the method is safe, it is the anæsthetic of choice in operations about the head, neck and thorax, and should reduce mortality for these operations. It is not contraindicated in any operation, and is believed to diminish operative shock. All the usual forms of this apparatus are trustworthy.

Luke[5] records some instances of *emphysema from intratracheal anæsthesia*. The subcutaneous emphysema was naturally due to a tracheal wound made with the catheter. It reflected in no wise on the method of narcosis, nor was it followed by serious consequences. Another case (unreported), different in character, ended fatally from the entrance of the catheter into a bronchus, plugging the latter, with distention and rupture of the lung.

Crile[6] gives some of his results in the use of *anæsthesia and anoci-association*. The author considers chiefly abdominal operations and operations for Graves' disease, and gives his technique for each. He emphasizes the two following points: that the technique of surgery is now standardized all over the world; and that to obviate the dangers of anæsthesia presents a vast problem for the future. After explaining how various substances produce their anæsthetic effects, he states that anoci represents the exclusion of all harmful results, by sparing the brain and the psyche. In other words, he depends as much as possible on local and nerve-trunk anæsthesia. In connection with Dr. Lower he has performed during the past year 629 abdominal sections under anoci-association, with a mortality of 1·7 per cent. Dr. Bloodgood has obtained analogous results by the same methods.

SURGERY OF THE BONES AND JOINTS.

Coley[7] gives details of some cases of *myositis ossificans traumatica*. Three are related in full, showing the difficulties in diagnosing these cases from sarcoma. Both patients are young adults; there were history of traumatism shortly before development and similar *x*-ray pictures. But in myositis ossificans the sharp outline, corresponding to the juncture of the tumour with the bone, is always present, while in sarcoma it is less marked, unless in the earliest stages. Again, myositis is harder to the feel and exhibits in general more pain. Coley would make diagnosis sure by cutting down. Treatment differs with the case—usually conservative.

Roberts[8] discusses *operative fixation as a cause of delay in union of fractures*. The author wishes to obtain a verdict as to the wisdom of using fixation in closed fractures. After having operated thus once with a resulting long period of consolidation, he consults the opinion of other surgeons through their writings. He is surprised to find that advocates of fixation often admit delayed union as a drawback. The author would use fixation for special indications. In ordinary cases the old plan secures "rapid bony union, absence of deformity, and absence of pain." Some eminent surgeons who have had much experience in the operative treatment of fractures, are first in enumerating possible drawbacks, including delayed union, yet still speak in praise of it.

Binney and Lund[9] relate *eighteen cases of separation of the lower femoral epiphysis*. The cases are tabulated and beautifully illustrated with photographs

and *x*-ray plates. Separation is simple or compound. The cartilage always participates in the injury. Frequent exposures to the *x*-ray are required after treatment, which is chiefly fixative, a single transfixing nail apparently being sufficient for retention. But precisely this resource tends to assist epiphyseal growth and prevents shortening of the limb. Injury to the cartilage at the time of accident may have the same effect.

Pfahler[10] writes on *Koehler's bone disease in the U.S.* The so-called Koehler's disease, which is limited to a single bone—the scaphoid of the foot—was first described in 1908, and has been seen for the first time in America by Pfahler, of Philadelphia. About nine cases have been reported in Germany. The author made his diagnosis from the localization, as shown by Koehler, but while some at least of the victims were perfectly healthy, the author's patient had bleeding gums and attacks of fever. He had several attacks at considerable intervals, and no history of traumatism. Whenever a boy between three and nine presents attacks of temporary lameness, and *x*-rays show an increased density at the ossifying point of the scaphoid of one foot, with pain and tenderness in the arch of the foot, the diagnosis is sufficiently established. Rest and massage, the former by immobilization, seem to be the logical treatment, and recovery occurs as a rule without deformity, the radiographs being normal. On the other hand, some degree of condensing osteitis of this one bone undoubtedly occurs, the bone then being smaller and more irregular than normal.

Coley[11] relates a single unique case of *sarcoma of the femur*, apparently cured for ten and a half years by his serum; then a sarcocarcinoma developed in the same member at the site of an *x*-ray dermatitis. We know that sarcoma can be produced in rats. The author is unable to learn how *x*-ray cancers can throw any light on the nature of that disease. It is possible that it so devitalizes the tissues that some universally present irritant can cause general cell proliferation. The same thing has, of course, been said of bruises, chronic irritation, etc.

Murphy[12] has written a long article on *arthroplasty*. He refers under this title to any methods which remove ankylosis, so that a working joint remains. His work goes back to 1900. In one hospital alone he has operated on 124 patients. The technique in the different joints does not differ essentially. The strictest asepsis is absolutely necessary. Sixteen cases are given to illustrate special localizations. The first step is to expose the joint and open its capsule; the ankylosis is freed. The originally ankylosed bone ends are treated for the establishment of the new joint, and an interposing flap of fascia, muscle, or fat inserted. There are many technical details.

DISEASES OF THE BREAST.

Miller[13] deals with a comparatively new disease, *carcinoma mastoides*, of which there are at present but twelve cases all told. It occurs chiefly in pregnant and puerperal women, and while really a fulminating form of mammary cancer, resembles strongly a subacute purulent mastitis. Thus far, the disease is so highly refractory to treatment that operation hardly prolongs life. In discussion, Rodman did not believe the disease so rare; he had seen ordinary cancers which took on this acute development, and they occurred in the non-pregnant also.

Syms[14] discusses the subject of *lymphangioplasty* (*Handley's method*). He secured only a failure when operating for brawny arm. The ratio of success here is about 50 per cent. In elephantiasis the operation has always failed. In various simple lymphagiomas or œdemas, cures have readily been effected. Erdmann reports one of the leg. A. S. Taylor cured lymphangioma of the arm following a dog-bite. There is a general opinion that the operation is in its infancy.

Speese[15] writes about *tumours of the male breast.* Dealing with carcinoma, he mentions the latest reports. Despite the alleged infrequency, this is relative only. Even as early as 1885 there were 348 cases of malignancy, some of which were probably sarcomata. The author regards 500 cases of cancer as a conservative estimate. To the total, whatever it be, the author adds two personal cases which call for no remarks. In discussion, Gibson mentioned 4 personal cases of apparent malignancy, only one of which was cancerous; the others were sarcoma (1), and fibro-adenoma (2). Rodman had seen 9 cases of cancer.

Deaver[16] gives a review of 534 operations on *the mammary gland.* The primary mortality has come down from 25 per cent to 1 per cent. The Halsted technical principles have brought local recurrence down to 6 per cent. Of a recent series of 200 cases operated upon, 31 should have been inoperable on account of metastases. Patients delayed until sixteen months as the average duration before operation. A cancer readily recognizable is usually inoperable. About 21 per cent pass the three-year post-operatory limit (one in five permanently cured).

THE CHEST, AND ORGANS OF RESPIRATION.

Lund[17] writes of *sarcoma of the chest wall,* and continuing Parham's work (1898) makes the total of subsequently operated cases 28. The mortality for such a formidable affection was very low—but two deaths. This evidently refers only to primary mortality. The material is all subsequent to Parham's, which dealt with resection of the thorax in general. The author reports a case because of the rarity of the affections, the excellence of the *x*-ray pictures, and because of the ease with which the lung was kept expanded with widely open thorax: intratracheal anæsthesia was used. The lung was inflated with bellows. Recovery.

Crile,[18] in an article on *laryngectomy for cancer,* reviews his work to date. He has now done 27 laryngectomies with 2 operative deaths. He limits his activities to early intrinsic cases, in which there is a possibility of radical cure. The causes of death were mediastinal abscess and tracheal necrosis with septic pneumonia. The operative deaths are present in about the same ratio in cancer of the tongue, rectum, etc. The author studied the statistics of all countries to find the causes of mortality (pneumonia, local infection, mediastinal abscess, vagus inflammation, inhibition of the heart, etc., through mechanical stimulation of the superior laryngeal nerve), and details the measures for averting each of these. The questions of the anæsthetic, and substitute for the larynx, are discussed fully. In nearly half the cases, tracheotomy was necessary. These growths seldom cause metastases, and when all is taken into account should be more readily curable than any other cancer. The author speaks of at least one three-year cure, but does not give the full statistics.

Barnes, Lake, and Fulton[19] deal with *pulmonary tuberculosis treated with artificial pneumothorax*. Seventeen cases were treated at the Rhode Island State Sanitarium. Nitrogen gas alone was used, and the technique was Forlanini's throughout. The cases were naturally of the severer types (all bilateral), with very bad prognosis. As to results—14 only tolerating the treatment—7 had temperature reduced to normal, 5 to a subfebrile point (99·5°) and 9 gained weight; but 8 who had been helped renounced the treatment, and 7 cases ended fatally, on an average of $5\frac{1}{3}$ months after treatment began. The authors would further test the remedy on less severe and unilateral cases.

King and Mills[20] discuss therapeutic artificial pneumothorax, as illustrated by 16 cases of pulmonary tuberculosis at the Loomis Sanitarium, Liberty, N.Y., which have recently been treated by the above method. Two have shown marked improvement, amounting perhaps to recovery, 6 have shown temporary or slight improvement, 1 case improved as to hæmorrhages; while 1 received no benefit, and 6 could not profit at all by the method on account of the amount of pleural adhesions.

SURGERY OF THE ABDOMEN AND ALIMENTARY CANAL.

W. J. M. Mayo[21] gives particulars relating to *surgery of the spleen*. Between April, 1904 and October, 1912, there were performed at the local clinic 27 total splenectomies, with two operative deaths. Of the total number, 18 were of splenic anæmia (including Banti's syndrome), while the other 9 were divided among floating spleen (2), tuberculosis (1), pernicious anæmia (1, diagnosis doubtful), cirrhosis of the liver (1), and cases termed "infections" (4). The two operative deaths occurred among the splenectomies for splenic anæmia. The case of floating spleen recovered; the patients with tuberculosis and cirrhosis of the liver survived but a few months. The case of so-called pernicious anæmia showed no improvement. The so-called infectious cases are not discussed. The author's mortality was about 8 per cent, much lower than in certain other series quoted, and he thinks that it ought not to exceed 5 per cent.

Wilson,[22] continuing the preceding article, deals with studies of eighteen spleens, the seat of splenomegaly. Very large, smooth spleens represent overgrowth of characteristic splenic tissue. The rougher spleens are the result of a later overgrowth of the splenic fibrous tissue. Great connective-tissue overgrowth and degeneration of splenic pulp are associated with cirrhosis of the liver.

Noland and Watson[23] describe three cases of the *spontaneous rupture of the malarial spleen* seen in the Canal zone. A very rare accident. It is dangerous to employ deep palpation, etc., in these cases, or to perform exploratory puncture. The victims were two negroes and a Spaniard. The symptoms were those of traumatic rupture. There were two recoveries. The third operation was successful, but the patient died of urinary retention.

Fowler,[24] in an article on *cysts of the spleen*, refers to non-parasitic cysts; he has collected the total material from the literature, including autopsy, puncture, excision, and drainage, partial and total splenectomy cases. The author's study of the entire subject is the first to appear since Bircher's in 1908.

W. J. Mayo[25] discusses *injuries to the pancreas* while operating on the stomach and spleen. In operating upon 378 cases of resection of the stomach, this occurred with 11 per cent. In 8 cases in which pancreatic attachments had to be divided, no added mortality resulted. In 30 splenectomies, the tail of the pancreas was wounded three times, but with no mortality. To deal with these injuries requires much technical resource. The pancreatic duct always escaped injury. Separated portions of pancreas may have to be fixed to the stomach or spleen. The author has resected the pancreas for tumour, with recovery. It makes the eighteenth case on record (10 recoveries, 8 deaths).

McDill[26] gives a paper, partly experimental in character, dealing with *lymph-angioplasty for chronic ascites*. A trocar wound is made and lymphangioplasty done for drainage. Loss of nutriment by repeated tapping is too costly. The author's procedure is by no means original in its idea. He punctures above the pubis under quinine and urea anæsthesia, and inserts a cannula through which three pieces of silk are passed by the aid of a carrier. The author's method differs from that of Mitchell and others in that drainage begins in the immediate vicinity of the puncture, so that the " peritoneal pond " slowly escapes beneath the skin.

Lund,[27] under the title of *" The Surgeon and the Ptosis Problem,"* gives an article typical of many similar papers. He refers to methods of visceral suspension in which he sums up the work of Jackson, Lane, Coffee, etc., and then gives his own views, viz. :—For simple ptosis, no surgery ; if constipation is present as a result of mechanical causes, he seeks to eliminate the " cesspool " by the procedure most suitable for the case, including separation of adhesions, extirpation of membranes, lateral anastomosis, ileosigmoidostomy, and even resection of entire cæcum and ascending colon, hepatic flexure, and part of the transverse colon (done twice by the writer). The author also discusses resection of the sigmoid and transverse colon (separately), and a form of lateral anastomosis for prolapse of rectum (McArthur's) which he has done successfully in one case. This field seems illimitable, and diagnosis is of the greatest importance, the *x*-rays being checked by all other methods. (He evidently does not believe in trial laparotomy in routine work.) But as to end results, we must expect relief only, for cure is not often realized. As for the proportion of failures, there is a belief that this is large.

Abbe[28] relates his personal experiences of *malignant disease of the mouth and tongue*. Within ten years he has treated 40 cancers of the tongue, 15 leukoplakias, 27 sarcomas of jaw (including epulis), 40 sarcomas of tonsil and pharynx, in addition to various cancers and benign tumours. He announces that of this group we can cure few with radium save in giant-cell sarcoma, in which it is a specific ; the same may come to be true of leukoplakia. Even in advanced cancers, in which the knife is our stand-by, radium may be an adjuvant.

Richter[29] has a practical article on *congenital atresia of the œsophagus*. Seventy per cent of all congenital malformations affecting the gullet consist of atresia, involving a tracheo-œsophageal fistula. Less than 150 cases have thus far been reported, and the lesion has always been essentially fatal, with or without treatment. The author first closes the gullet opening at the bifurcation of the trachea by the transthoracic route, followed at once by gastrostomy. The

former intervention is the severest. Anæsthesia is with ether of the Meltzer-Auer type. The steps preliminary to ligation of the gullet comprise those used in all deep intervention in the thorax. The gullet is isolated and closed by a very elaborate technique, and the chest closed. Gastrostomy is then performed. The author has seen this condition four times. Two babies died without any intervention and two were subjected to operation, the first dying from shock, while the second lived twenty hours. It had taken eight ounces of milk through the gastrostomy tube. Death was evidently due to bronchial infection before operation. The author thinks that his good technical result in two cases warrants a hope of ultimate success.

Torek[30] gives an account of *the first successful resection of the thoracic portion of the œsophagus for carcinoma* in a brief preliminary report. The patient is a woman of 67 years. She had already submitted to a gastrostomy. The author entered the thorax through the seventh intercostal space, then made a cross incision at the back of the chest extending to the fourth rib, the line corresponding to the angles of the ribs. Vagus collapse was averted, and the pulse remained constant. Small thoracic branches of the aorta having been ligated, the œsophagus was drawn into the field, and carefully detached from the pleura. The œsophagus was divided and drawn outside the thorax through an opening above the clavicle. The woman made an amazingly quick and sound recovery. Details will be published later.

W. J. Mayo,[31] in an epoch-making paper on the *operative treatment of cancer of the stomach*, comes to the conclusion that at present cancer of the pylorus can be diagnosed so as to permit radical operation in about one-half of all cases. The operative mortality is about 10 per cent, and by using a little selection based on the patient's condition, it can be reduced to below 5 per cent. About 25 per cent of those who survived operation should attain the five-year cure, while as regards the three-year cure, 38 per cent should be alive and free from recurrence at the end of that period. Mere resection gives on average not above one year's survival. In the discussion of this paper, Rodman would try to improve the percentage of recoveries by excising all pyloric ulcers. He has done this for thirteen years. Deaver added that exploratory laparotomy had practically no mortality and is freely available in the diagnosis of pyloric affections.

Scudder[32] has collected from literature 21 cases of the very rare affection, *sarcoma of stomach*, which were all he could find, and he adds another. One year only had elapsed since his operation, the patient having made a complete recovery for the interval. The first diagnosis was duodenal ulcer. (There had been hæmorrhage from the bowels.) Laparotomy, with intent of performing a jejunostomy, revealed the real condition. After the operation, patient improved greatly, and a partial gastrectomy was done, extirpating the growth.

Outerbridge[33] has written a monograph on *carcinoma of Vater's papilla*, containing all records of cases in the literature. There are some successful extirpations on record, but no cures (three-year limit). Little is known of the histology and pathogenesis. The duration of the disease unchecked is seldom over seven months. Death is due in most cases to cholæmia.

McDonald[34] reports a case of *congenital atresia of duodenum* (a rare abnormality of which perhaps 50 are on record). This case was complete atresia, so that the manifestation appeared very soon after birth. No other anomalies were

noted. Diagnosis of pyloric stenosis. Death occurred after several days. The condition was revealed at autopsy.

W. J. Mayo[35] gives his experience of *excision of ulcers from anterior wall of duodenum.* This paper refers naturally to operations unaccompanied by gastro-enterostomy. The author and his brother have excised 52 of these ulcers, and both immediate and end results are good. In a few cases ulcers were also found on the posterior wall and in the pylorus. In these multiple cases gastro-enterostomy was indicated. Should the ulcers of the anterior wall turn out to be of the gastric type—thickened and callous—the policy of excision would be of doubtful value.

Ladd,[36] under the heading of *progress in intussusception,* refers to the statistics of the Children's Hospital, Boston. In the period 1908–1913 there were ten times as many recoveries as in 1903–1908 (world-wide figures). Practitioners bring their cases in earlier, and we have the bismuth *x*-ray diagnosis. Patients operated on within thirty-six hours should recover. The series 1908–1913 embraced twenty cases, with a mortality of 45 per cent, much greater than Chubb's 8 per cent in fifty cases, but a great improvement on their own (90 per cent between 1903 and 1908).

White[37] puts forward the idea of the *contracture of psoas parvus muscle, simulating appendicitis.* The author reports seven cases in which the appendix was found normal, despite the clinical picture of appendicitis, and in which he suspected the latter to be due to contracture of the psoas parvus tendon. In pseudo-appendicitis, surgeons usually invoke adhesions or mechanical anomalies, or a neurotic element. Only one of the author's patients was of this last-named type. In the literature, the author finds only hysterical or functional spasms, without reference to appendicitis. In the author's cases, tenotomy was performed with marked success.

Eastman[38] discusses the presence and significance of *the fœtal peritoneal folds,* in an article representing a thorough study of the fœtal membranes so frequently mentioned by Lane as the indirect cause of intestinal stasis. The subject is by no means modern. The folds were known to Virchow, and numerous surgeons have noticed their existence in certain localities and given them names for the most part topical. Treves' " bloodless fold," Douglas Reid's " genito-mesenteric fold," Jonnesco's " parietocolic fold," are all discussed by the author in connection with Jackson's membrane, because all these three structures are fœtal. He concludes that fœtal studies will never solve the problem, which must be done by a composite study of the work of Flint, Mayo, Lane, Jackson, Connell, Pilcher, Coffay, Binnie, Gerster, and Martin.

Jackson,[29] the discoverer of " Jackson's membrane," writes an extensive paper on *membranous pericolitis and allied conditions of the ileo-cæcal region.* He discusses the treatment of the colon in these cases, without advocating any classical procedure. Among numerous competitive operations, he mentions a cæcosigmoidostomy recently devised by Youmans, of New York.

Douglas[40] reviews the subject of *diverticulitis of the sigmoid.* The modern American literature of this condition goes back to about 1907, when Brewer reported 6 cases of left-sided abdominal suppuration, in two of which diverticula were present. In the same year Mayo reported 5 cases. In 1908, Telling, of England, collected from all countries notes of 105 cases adapted for analysis.

At the Mayo clinic 27 cases have been reported, C. H. Mayo saying that in only 9 was a diagnosis made. Since Telling's paper of 1908, many new cases have been reported. A weak spot in the intestinal wall paves the way for the diverticula, which may be very numerous, yet cause no trouble at first. Eventually inflammation follows, involving adhesions with the bladder, inflammatory thickening of the gut, perforative peritonitis, perforation of bladder, and cancer. Symptoms on the left side, simulating appendicitis, should suggest perforating diverticulitis. Statistics show it to be a disease which develops at about fifty-five years.

Brown[41] writes an article on the *complete physiological rest of the large bowel in certain affections of the latter.* Among the colonic conditions referred to, are mucous colitis, with obstruction, ulcerative colitis, and obstructions of the colon by tumours. In mucous colitis some stasis is usually present ; the cæcum is in the pelvis fixed by adhesions, and there are angulations at the hepatic and splenic flexures, the transverse colon sagging. The author is a believer in short-circuiting operations for this condition, and has operated, often without benefit. After mentioning the other affections, he gives an account of his operation for " resting " the bowels. He loosens the cæcal adhesions, and ties off the distal portion of the ileum, which is buried. In an incision in the cæcum, a catheter is fixed opening externally. The divided end of the ileum is provided with a tube, which constitutes an artificial anus. In his way both cæcum and small intestine are amply drained, and this gives to the colon its needed rest. When the latter has healed, the ileum may be anastomosed laterally to the ascending colon or sigmoid. The author has operated on ten cases. These cases of malignancy and one of tuberculosis were relieved, while the other four were cured.

Dr. W. C. Lusk[42] and others discussed before the New York Surgical Society, *rectus transplantation in radical operations for inguinal hernia,* in which the whole subject of ligature material was involved. The transplantation is done chiefly when there is deficiency of the internal oblique muscle, and in both direct and indirect hernia. Downes had done this operation 165 times, and as far as he knows, but a single failure has occurred. He used two layers of suture material under the cord. Coley approved of this plan. Moschkowitz has seen numerous failures, and blames the choice of suture material, which he now believes should be absorbable. Dawbarn thought recurrence to be due to separation of the conjoined tendon from Poupart's ligament. He uses non-tension sutures of linen, and believes that they are now used at the Mayo clinic and by others. Coley defended absorbable sutures ; Gerster used silk for many years, until he began to have infections and changed to chromic gut. Lusk, who reported a new method of rectus transplantation on a former occasion, had since learned that he had been preceded by Halsted, Bloodgood, Wölfler, Berger, and others, most of these surgeons having apparently originated the operation independently.

SURGERY OF THE HEART AND VASCULAR SYSTEM.

Stewart[43] gives an account of *five cases of suture of the heart.* Despite the numerical frequency of reports of heart suture, the author states that this has been done by Philadelphia surgeons but eleven times. Two cases have never been reported. Six of the eleven cases have recovered. The author, as a result

of his work, does not believe in pericardial drainage after an operation on the heart; but if, after complete closure of the sac, pus regathered, drainage is of course inevitable. Of four cases in which he practised complete closure, no empyema formed. One died within an hour. The last lived forty-one hours, the sac being distended with fibrin.

Matas and Allen[44] have made an experimental study of the *practicability of reducing the calibre of the thoracic aorta by plication*. They claim that they have all but succeeded in plicating this vessel in the dog. No animal has yet survived the third plication. For the present, all these aneurysms in men must be exposed (thoracic and abdominal aorta), and the older resources employed. Suture and plication, despite their lack of success in the dog, may yet prove feasible in mankind.

Halsted[45] writes on *partial occlusion of the thoracic and abdominal aortas by bands of fresh aorta and of fascia lata*—a paper which is wholly experimental in scope and is a late development of Porta's efforts to secure partial occlusion of arteries. The bands tend to absorption. The femoral tension is not increased. Successful constriction might succeed in curing certain aneurysms.

Meyer[46] discusses the *surgery of the pulmonary artery*, with special reference to an original case. The author first reviews the Trendelenburg operation for embolus of the pulmonary artery. This intervention is successful in animals only, and is pronounced by some of no value, because in successful cases, survival either is impossible or would have occurred spontaneously. In the United States the delay of seeking the consent of patients' relatives would be fatal. Meyer believes that with a more careful selection for indications and the use of Sauerbruch's cabinet, the operation may yet succeed in man. The indication should be limited to embolism of protracted course. He has operated on one case, in which the patient, a woman aged 70, died on the table.

Vaughan[47] describes some cases of *aneurysm treated by Matas' method*, and endorses the claim of many that Matas' work is the most progressive step since the activity in this field of John Hunter. He reports two cases treated by the method, in one of which death occurred, but not from the operation or the aneurysm; these were seated in the external iliac and popliteal arteries respectively. In the first case, arterial blood entered the sac when the external iliac was compressed. The source of this blood-flow was unknown. Hence, entrance into the sac was made and the vessel ligated. Collateral circulation was soon established.

McWilliams[48] contributes a partially successful case of *arteriovenous femoral anastomosis (lateral transverse) for threatening gangrene*. The patient, male, aged 53, had already lost two joints of his second left toe. Six years before, he had to lose his right leg for gangrene extending up the foot. The left toes continued to die. The author, in order to save the foot if possible, did a Bernheim transverse anastomosis, as done with success eleven times by the latter. The operation was promptly done, and was followed by intense pain for five days. The circulation in the foot became re-established. The popliteal pulse cannot be felt. The stump of the second left toe, which had been amputated some time before the operation, was the only portion of the foot which presented active symptoms. It will doubtless require amputation.

SPINE, SPINAL CORD, AND NERVES.

Rugh[49] describes *ten cases of Albee's bone grafting for Pott's disease*. The cases are freely illustrated, showing the removal of the tibial graft and its insertion into the vertebral canal. The author extols the simplicity of the operation, the absence of shock and elements which contraindicate operation, the complete fixation and immobilization of the spine without interference with function. A plaster-of-Paris jacket or steel brace may be worn later, the first-named to be preferred. The author would prolong fixation over the interval taught by Albee —at least eight months of outward support, and more if occupation strains the spinal column.

Frazier[50] writes on *the relief of gastric crises in tabes dorsalis by rhizotomy*. He did his first operation of this sort on Sept. 19, 1911, following Förster's original technique. At present, the results of the intervention show the greatest improvement over the original condition. There is a difference of opinion as to whether the nerve roots are best divided without or within the dura. The author believes in opening the latter for the better separation of the anterior and posterior roots. About 30 rhizotomies have been performed for this condition, with 9 complete recoveries, 16 cases of improvement, and 5 deaths.

Elsberg,[51] under the title of *experiences in spinal surgery*, details the conclusions derived from 70 operations on the spine, of which 60 were primary laminectomies and the remainder secondary interventions. With experience, the intervention becomes easy, provided osteoplastic flaps are not involved, and these are seldom necessary. Hemilaminectomy has a very narrow field. The technique is more simple than in cranial surgery. One stage ordinarily suffices. A least two, and as many as seven spines and laminæ may require removal. Tight closure of the dura and paravertebral muscles is essential, and drainage should never be required after laminectomy. The dura should not be opened before oozing in the superjacent structures has ceased, and if possible the pia should be opened afterwards to prevent access of dural blood to the cord. Many cases of removal of tumours of the cord are given.

Taylor and Casamajor,[52] in discussing the *operative intervention in traumatic Erb's paralysis*, report some original cases, and admit that their results are by no means brilliant. This was due to conditions which could not be made to yield recovery; or rather, the operator would have done more ultimate harm than good. Results are late, and benefit rare. Operation gives better results than a let-alone policy, and is essentially simple if the nerves can be loosened and resected preparatory to end-to-end suture. This may at times be effected by fracture of the clavicle. Post-operative fixation may be necessary for from six weeks to six months.

DUCTLESS GLANDS, GENITAL ORGANS, AND SKIN.

Parker[53] has collected reports of *fifty cases of thymectomy*. He states that thymus gland surgery is for the most part emergency in character, and practised in infants and young children. He has been able to find but one case in an adult, operated on by Garré. The patient also had Graves' disease. The author has carefully tabulated the fifty reported cases, and has drawn from their analysis a complete description of the disease. There have been only some half-dozen

American operators. Even the Mayos have published only a single case. After compilation of his table, the author learned of a recent case by Schroeder, of Chicago. In speaking of the non-emergency or continuous cases, and their intermittent form, the author states that in either case crises occur, and one of these may be severe enough for intervention. The mortality (33½ per cent) is sometimes due to complications, but more often to some previous surgical intervention or infection. There was always more or less survival, not a death occurring on the table. The method preferred at present is the intracapsular, which is simple and easy. General anæsthesia is well borne. In other words, the so-called " thymic death " has not been seen in thymectomy.

C. H. Mayo,[54] in writing of the *surgery of the thyroid*, draws his conclusions from the 5000 cases treated at Rochester, Minn., during the past twenty-five years. The number of goitres in the ordinary sense was very nearly the same as that of the Basedow or exophthalmic type (2396, 2295). There were 59 operations for malignancy, and 309 operations done early, in which no diagnosis seems to have been made. (These were probably cases of simple goitre.) Basedow's were treated with double and single ligations, extirpation, and partial thyroidectomy. The mortality of operation has come down from 25 per cent to 1 or 2 per cent. Of Basedow's, 75 per cent are cured and the rest improved.

Crile[55] writes of *aseptic wound-fever and post-operative hyperthyroidism*. In demonstrating the identity of these two conditions, the author states that when centripetal stimuli from a wound were barred by urea hydrochloride and quinine, and with further exclusion of psychic and traumatic stimuli, the post-operative temperature and pulse commonly known as aseptic wound-fever do not occur. He had already observed that the technique which controlled the one also controlled the other. This technique, in direct reference to hyperthyroidism, was the feature of anoci-association, which dealt with the emotional sphere.

Gerster and Mandelbaum[56] have described a case of *the formation of a bone in the human penis*, which is said to be almost unique; but literary research shows now a total of 16 cases.

J. S. W. Davis[57] describes the *extensive thickening of Thiersch grafts due to amidoazotoluol*. He mentions the prevalent scepticism as to the healing powers of certain substances which contain amido-bodies like scarlet red. Amido-azotoluol, a constituent of the latter, was used on portions of Thiersch grafts, and these were stimulated to double their normal thickness, while controls retained their original thickness. No tendency to malignant overgrowth has been noted. The case was held to be unique.

REFERENCES.

[1] ESTES, *Ann. Surg.*, 1913, July.
[2] BECKMAN, *Ibid.*, 1913, lvii, 718.
[3] ASHHURST AND JOHN, *Amer. Jour. Med. Sci.*, 1913, June and July.
[4] ROBINSON, *Surg. Gyn. and Obst.*, 1913, xvi, 297.
[5] LUKE, *Ibid.*, 1913, xvi, 204.
[6] CRILE, *Ibid.*, 1913, xvi, 627.
[7] COLEY, *Ann. Surg.*, vii, 305.
[8] ROBERTS, *Ibid.*, lvii, 545.
[9] BINNEY AND LUND, *Rep. Boston City Hosp.*, 1913, 197.
[10] PFAHLER, *Surg. Gyn. and Obst.*, 1913, Nov.

[11] COLEY, *Ann. Surg.*, 1913, July.
[12] MURPHY, *Ibid.*, lvii, 593.
[13] MILLER, *Ibid.*, 1913, lvii, 733.
[14] SYMS, *Ibid.*, 1913, lvii, 583.
[15] SPEESE, *Phila. Acad. of Surg.*, 1913, 9.
[16] DEAVER, *Jour. Amer. Med. Assoc.*, 1913, lx, 795.
[17] LUND, *Ann. Surg.*, 1913, Aug.
[18] CRILE, *Ibid.*, 1913, lviii, 164.
[19] BARNES, LAKE AND FULTON, *Bost. Med. and Surg. Jour.*, 1913, clxviii, 917.
[20] KING AND MILLS.
[21] MAYO, *Surg. Gyn. and Obst.*, 1913, Mar.
[22] WILSON, *Ibid.*
[23] NOLAND AND WATSON, *Ann. Surg.*, lvii, 71.
[24] FOWLER, *Ibid.*, lvii, 658.
[25] MAYO, *Trans. Amer. Surg. Assoc.*, 1913, May.
[26] MCDILL, *Surg. Gyn. and. Obst.*, Nov., 1913.
[27] LUND, *Rep. Boston City Hosp.*, 1913, 59.
[28] ABBE, *Med. Rec.*, 1913, lxxxiii, 46.
[29] RICHTER, *Surg. Gyn. and Obst.*, 1913, Oct.
[30] TOREK, *Jour. Amer. Med. Assoc.*, 1913, lx, No. 20.
[31] MAYO, *Ibid.*, 1913, Aug. 23.
[32] SCUDDER, *Ann. Surg.*, 1913, Aug.
[33] OUTERBRIDGE, *Ibid.*, lvii, 402.
[34] MCDONALD, *Amer. Jour. Med. Sci.*, cxlvi, 28.
[35] MAYO, *Ann. Surg.*, 1913, lvii, 691.
[36] LADD, *Bost. Med. and Surg. Jour.*, 1913, 168, 542.
[37] WHITE, *Ann. Surg.*, 1913, Oct.
[38] EASTMAN, *Surg. Gyn. and Obst.*, 1913, xvi, 341.
[39] JACKSON, *Ann. Surg.*, lvii, 374.
[40] DOUGLAS, *Ibid.*, 1913, Sept.
[41] BROWN, *Surg. Gyn. and Obst.*, 1913, xvi, 610.
[42] LUSK *et alia*, *Ann. Surg.*, Nov. 1913.
[43] STEWART, *Ibid.*, lviii, 66.
[44] MATAS AND ALLEN, *Ibid.*, 304.
[45] HALSTED, *Ibid.*, 183.
[46] MEYER, *Ibid.*, 188.
[47] VAUGHAN, *Trans. Amer. Neurol. Assoc.*, 1913, May.
[48] MCWILLIAMS, *Ann. Surg.*, 1913, lviii, 411.
[49] RUGH, *International Clinics*, 1913, xxiii, 130.
[50] FRAZIER, *Amer. Jour. Med. Sci.*, 1913, cxlv. 115.
[51] ELSBERG, *Surg. Gyn. and Obst.*, 1913, Feb.
[52] TAYLOR AND CASAMAJOR, *Ann. Surg.*, 1913, Nov.
[53] PARKER, *Amer. Jour. Dis. Child.*, 1913, Feb.
[54] MAYO, *Jour. Amer. Med. Assoc.*, lxi. No. 1, 1913.
[55] CRILE, *Ann. Surg.*, 1913, lvii, 648.
[56] GERSTER AND MANDELBAUM, *Ibid.*, 689.
[57] DAVIS, *Johns Hop. Hosp. Bull.*, 1913, June.

VISITS TO SURGICAL CLINICS AT HOME AND ABROAD.

SIR VICTOR HORSLEY'S CLINIC AT THE NATIONAL HOSPITAL FOR THE PARALYZED AND EPILEPTIC, QUEEN SQUARE.

PHYSIOLOGY, pathology, and surgery owe a great deal to Sir Victor Horsley; and his pre-eminence in the surgery of the nervous system is based on the most satisfactory and enduring of all methods, that of careful original research on the structure and functions of the important parts he has to operate on. Unlike many successful surgeons, he has carried his investigation right up to the present time, as the pages of *Brain* and other publications reveal.

Formerly Horsley was surgeon to University College Hospital, but the increasing demands of public work on the one hand, and of private practice and research work on the other, compelled him to relinquish that position some seven years ago. Until quite recently, however, he directed a special research laboratory at University College, where many important discoveries relating to the structure and functions of the nervous system were made.

Sir Victor is still on the active staff at the National Hospital for the Paralyzed and Epileptic, Queen Square. This famous hospital, founded in 1859, has 160 beds and a convalescent branch at Finchley. There are no beds reserved for surgical cases exclusively. Medical visitors from all parts of the world are attracted to the hospital by the wealth of clinical material, the excellence of the teaching, the enthusiasm and brilliance of the staff, and the high reputation which it gained by its association with the great Hughlings Jackson, and many other famous neurologists, such as Buzzard, Charlton Bastian, Sir William Gowers, and Sir David Ferrier, to mention only a few.

As an instance of the material available, we may refer to the series of 497 cases of cerebral tumour which Dr. Tooth was able to collect from the records of the hospital over a space of 10 years. Horsley's operations on the central nervous system run into hundreds, and as far back as 1907 he had removed the Gasserian ganglion in 120 cases.

By the courtesy of Sir Victor and of Dr. Walshe, the Resident Medical Officer, we were enabled to see some of the operative work.

Tuesday, at 9.0 a.m., is the usual hour for operations, but it is necessary to enquire beforehand, as the supply of patients requiring surgical treatment varies much from time to time.

The theatre is well designed and lighted, with a separate entrance for visitors, who are not required to wear any overalls or special boots, but stand in a gallery sufficiently near the table to see well all that is done.

Loud talking and coughing are strictly prohibited, great stress being laid on the danger of wound infection by contamination in this way.

In every case of suspected brain tumour a skiagram is taken, and occasionally very valuable information is thus obtained. In one case recently, very definite shadows were shown by a tumour with calcareous areas.

As a routine Horsley's patients are given 10 grains of urotropin three times a day by the mouth. This is begun a day or two before the operation, and continued until the wound is healed. Crowe and Cushing showed that this drug is excreted into the cerebrospinal fluid, and is able to exert a definite inhibitory effect on the growth of pyogenic organisms. A nutrient enema containing beef-tea is also given just before the operation.

The patient is anæsthetized in a side room with chloroform and oxygen given with a Vernon Harcourt inhaler, and it appeared to be highly satisfactory. No hypnotic drugs are given beforehand. The surgeon washes thoroughly in soap and water, followed by immersion of the hands and arms in a solution of mercury perchloride; he then puts on a sterile long-sleeved gown, and his head, nose, and mouth are enveloped in layers of gauze; finally, rubber gloves are put on.

There are three assistants, one of whom directs a stream of 1–4000 perchloride from an irrigator on to the wound during the whole course of the operation, thus keeping the field bloodless, and avoiding frequent swabbing and the bruising of brain tissue, which is likely to occur when sponges or gauze are pressed on it.

Assistants and theatre sister are all dressed in complete overalls and masks, no unnecessary skin surface being exposed.

A short resumé of the case was given while anæsthesia was being induced. The patient, a boy of 12, had had attacks resembling petit mal, with the visual aura, for five years; during the attacks there was partial loss of consciousness, deviation of head and eyes to the right, twitching of the right side of face, and rigidity of right arm, followed by automatism. For five years, there was frequent left-sided headache; but no vomiting, and no true optic neuritis. Right-sided hemianopsia was present. The surgeon pointed out that these visual phenomena suggested a tumour of the left occipital lobe, but that the petit mal attacks made it possible that the tumour was more deeply seated in the occipito-temporal region, and that therefore the indications were to expose the occipital pole, and then, if necessary, extend the opening in the skull downwards and forwards. The head, which had been completely shaved and prepared by carbolic compresses twenty-four hours previously, was now supported on a special head-rest invented by the operator, with the left side of the head well exposed. Towels wrung out of perchloride solution were now clipped to the scalp with small towel clips, so as to leave bare just sufficient area of skin. A gauze wick soaked in the same solution was plugged into the external auditory meatus. Sir Victor then explained that he did not use the osteoplastic flap method, because it so restricted the available field, and that he preferred to remove as much bone as might be necessary with trephine and forceps.

A large curved incision was made down to the bone, and a flap of soft tissue rapidly reflected; hæmorrhage was controlled by pressure on the flap, while bleeding points were picked up one by one with a powerful long-handled curved Spencer Wells forceps.

The reflected flap was protected by gauze and the surface of the bone examined. The surgeon explained that hyperæmia of the bone was sometimes produced by underlying tumour, but that in children it was particularly difficult to estimate whether there was hyperæmia or not in the early stages. A 1-in.

trephine of Sir Victor's own pattern was used to remove a button of bone very rapidly from the posterior part of the occipital bone, and this opening was enlarged with powerful long-handled cutting bone-forceps after separating the underlying dura. A roughly quadrilateral hole was thus produced in the skull, bounded behind by the lateral sinus, and towards the mid-line by the superior longitudinal sinus. Bleeding from the cut surface of the bone was readily stopped by Horsley's wax.

There was no marked bulging of the dura mater, and the brain was pulsating.

After twisting the vessels and sewing up the skin flap with interrupted fishing-gut sutures, the first stage of the operation was completed; it had lasted just half an hour. The patient was returned to bed and was well propped up with pillows.

A week later, the patient was re-anæsthetized in the same way and brought into the theatre. The boy had reacted well from the shock of the first-stage operation, but two days after had had two attacks similar to the previous ones; and although the facial weakness improved for a time, it had now returned and was of the " emotional " type, strongly suggesting that the tumour had reached the optic thalamus.

The flap was turned down again, and a little blood-clot between it and the dura gently scraped away. A flap of dura mater was now turned backwards by incising it on a dura mater protector parallel to the edge of the opening in the bone. The brain bulged through slightly, but not so much as would be anticipated with a rapidly growing or malignant tumour, and palpation of the cerebral tissue did not give in this case any abnormal sensation. Great care was exercised throughout to avoid any undue handling or rubbing of the cerebral tissue.

When troublesome bleeding occurs from the cerebral tissue, Sir Victor uses small pieces of fresh muscle tissue, snipped from the neighbouring flap and applied to the bleeding area—it often acts like a charm, but was not necessary during the operation described. A 4-in. fine trochar was thrust into the lateral ventricle, but it did not appear to contain any great excess of cerebrospinal fluid.

It was explained how difficult it is in such cases to decide whether to go on and incise the cortex in order to expose the tumour, or to be content with a decompression operation. In this case the age of the patient was an important factor, since children bear the shock of such operations poorly, and it was thought best to abandon the search for an intraganglionic tumour. More bone was therefore removed, so as to allow freer decompression space; no attempt was made to sew up the dura, the flap was re-sutured with interrupted sutures, and the head covered in moist cyanide gauze dressings, with a jaconet sheet pinned over the whole.

We were particularly impressed with the admirable co-operation which exists between physician and surgeon in the diagnosis of these difficult cases; the extreme simplicity and efficiency of the technical details of the operation, the judicious combination of asepsis and antisepsis in dealing with the wound; the value of the continuous irrigation; and the rapidity with which everything is done—obviously a very important matter in such grave operations.

Nothing could be more remarkable than the accuracy and efficiency with which the huge bone forceps that Sir Victor uses was made to do its work. Every cut removed the exact amount of bone necessary without splintering, and without injury to the dura or brain.

THE SURGICAL WORK AT BERCK-PLAGE.

By S. W. DAW, Leeds.

At a time when the subject of the treatment of tuberculosis is so much to the fore in this country, it seems likely that a brief review of the French methods of dealing with the disease in its surgical aspects may be of some interest. Mr. H. J. Gauvain has published several important papers in England describing in detail some of these methods, together with his modifications. The present article will merely reproduce some impressions gained during a recent stay in Berck, and may suggest some improvements in our treatment, both in general and as to technique.

Berck-Plage is on the north coast of France, not far from Boulogne, and lies near the southern extremity of an unbroken stretch of sands more than a dozen miles in length. Its aspect towards the Channel is due west, and it is protected

Fig. 332.—The Hôpital Maritime at Berck-Plage.

from easterly winds by a wide range of sand dunes. It is exposed to every other wind that blows, and there is usually a strong breeze. The climate is equable without wide variations.

The town of Berck adjoins the Plage, and is situated among and behind the sand-hills. It is for practical purposes devoted to the cure of surgical tuberculosis. One of the principal buildings is the Hôpital Maritime (*Fig.* 332). Founded in 1861, and supported by the French government, it has been gradually increased in size, till it now accommodates 1100 children from two to fifteen years of age. These patients are drawn from the Paris hospitals, and are sent for treatment in monthly contingents. The Maritime Hospital is in charge of Drs. Ménard, Calvé, and Audrieu, while six internes from the Paris hospitals form the resident medical staff.

There are also several large hospitals at the northern end of the town: the Orthopædic Institute, the Rothschild, and the Cazin, with Dr. Calot as

surgeon-in-chief. In addition to the hospitals, there are numerous private institutes and nursing homes.

All the hospitals are very near the high-tide mark, it being claimed that the therapeutic effects are much superior in such a situation to those attained even at a few hundred yards further from the sea.

Arrangements are made for the patients to spend as much time as possible during the day on the sands or on the hospital balconies. One sees also on the sands large numbers of pony and donkey carriages of special construction, containing tuberculous cripples of all kinds (*Fig.* 333). The principles of fresh air do not, however, appear to be carried to such an extent as in those of our English clinics, where the patients live in the open air day and night all the year through.

FIG. 333.—INVALID CARRIAGE FOR TUBERCULOUS CRIPPLES.
The back opens out, and the patient is slid in upon his tray.

In addition to sea air, good feeding and sunshine are the chief factors in the general treatment of the disease. Sunshine is valued for its local effects also, and the site of the lesion is exposed as far as is practicable to the direct rays of the sun.

It is perhaps worthy of note that French surgeons, though not opposed to the use of tuberculin, do not appear to place much reliance on its therapeutic value.

As regards the local treatment of tuberculosis, it may be said at once that the keynote is extreme conservatism, avoidance of sinuses, and the prevention and correction of deformities. It is unfortunate that to so many of us the term conservative treatment implies merely leaving the patient alone, but this is by no means the sense of the phrase at Berck. Strict immobilization is practised, combined with careful watching for collections of tuberculous pus and the prevention of sinus formation. If the affected part is in a good position, this is maintained by carefully-fitted apparatus; if the position is bad, it is gradually rectified in an appropriate manner, and these rectifications are among the most

striking features of the surgery at Berck. The name of Calot is associated in English minds with the forcible rectification of the deformities of Pott's disease. By this method good results were often obtained, though it is now to be regarded as a valuable piece of pioneer work which served its turn, but has given way to the safer and equally effective plan of gradual rectification. One has only to see the results of treatment to be convinced that it is not only possible and safe, but also imperative, to rectify the deformities of tuberculosis, whatever their situation.

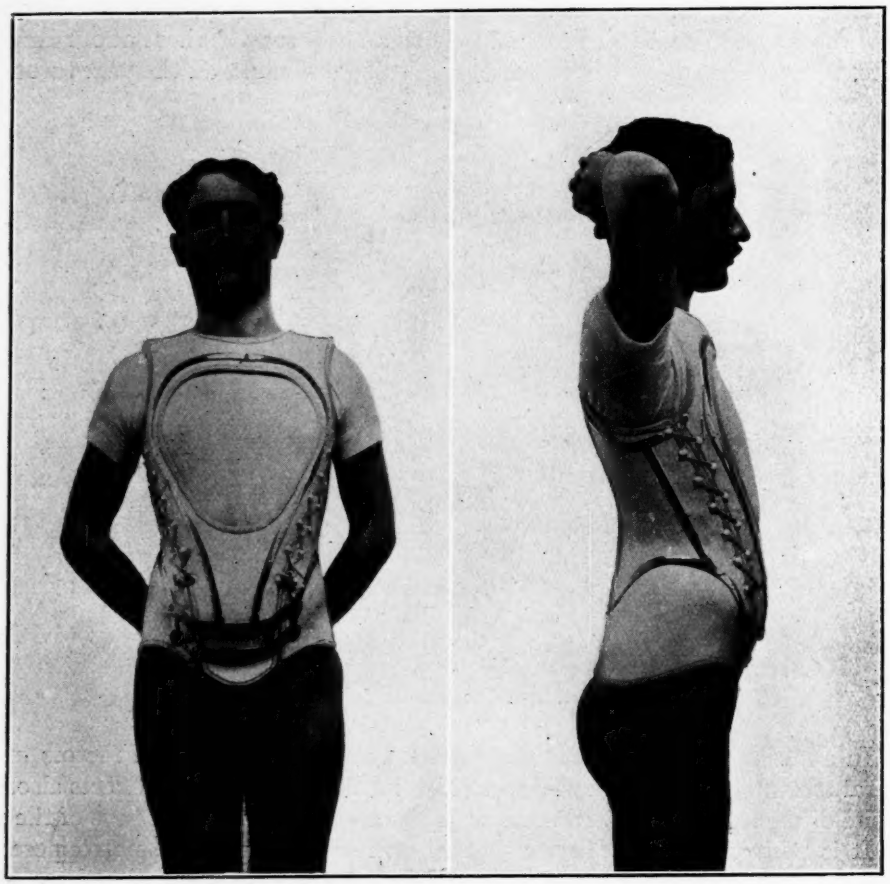


FIG. 334.—FRONT AND SIDE VIEWS OF THE CELLULOID JACKET.

During and after correction, the method of fixation by plaster-of-Paris casings is that most frequently used, and the technique of the application of plasters is most excellent among the French surgeons.

The part to be enclosed is covered with one or two layers of flexible knitted material, which is made to fit closely. A slow-setting plaster on soft bandages is applied, and one or more pleats or backward folds are made in each turn of the bandage. These are valuable both to redirect the bandage in the desired line and to prevent undue constriction. The moulding of the plaster to fit round the various *points d'appui* is of the greatest importance.[1]

In that stage of convalescence at which the patient is allowed to walk, an immobilization which is practically perfect is obtained by the use of celluloid appliances (*Fig.* 334), which are very light and well suited to this stage of the disease. These appear to be particularly effective and comfortable.[2]

A brief reference will now be made to some of the lesions which are treated, particular attention being called to points which seem noteworthy.

SPINAL CARIES.

The French surgeons are not in favour of any operative treatment, being opposed to all forms of internal splints; nor do they consider the ambulatory method, as often employed in Great Britain and America, suitable to the progressive stages of the disease, where complete immobilization is aimed at. This is attained by the use of the horizontal position, combined in most cases with the application of plaster jackets. The pros and cons of the various lines of treatment are well and succinctly discussed by Calvé.[3]

The " petit lit " of the Maritime Hospital is a light wooden tray lined with a thick firm mattress. The patient lies on this, and is kept in position by a canvas jacket fixed to the frame. When hyperextension is desired, as in lumbar or dorsi-lumbar disease, this is attained by the use of a cross-bar of wood placed beneath the mattress at the level of the lesion. This bar is gradually replaced by larger ones, and in this way slow correction of the deformity is very effectively brought about.[4] The patients can easily be lifted in these trays and placed in the open air on balconies or in carriages.

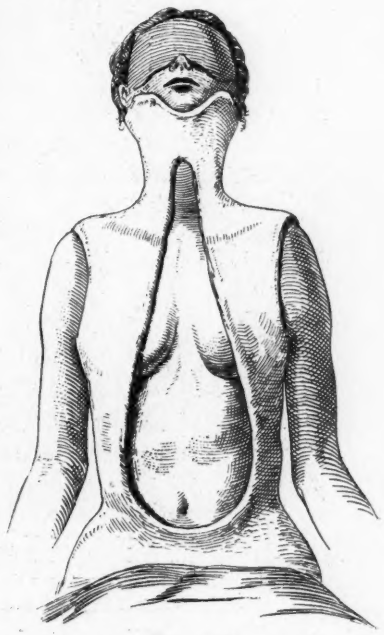


FIG. 335.
THE HIGH PLASTER (" MINERVA ").

Calvé[3] makes a very strong point of the difference needed in the mechanical treatment of lumbar and cervical caries on the one hand, and dorsal disease on the other. He proves conclusively that while hyperextension is of the utmost importance in the former class, it is futile in dorsal cases, and even tends to aggravate the deformity. The cross-bar is therefore not to be used for dorsal caries, and the principles of the application of plasters in the two classes are intrinsically different. All plaster jackets are put on with the patient suspended by the chin and occiput. Where hyperextension is desirable, the patient rests on tiptoe with the weight of the body forward, so as to hyperextend the spine. In dorsal cases the patient sits on a stool with the hips slightly flexed, the cervical and lumbar regions being kept practically straight.

In lumbar and lower dorsal lesions, the middle plaster is used, reaching over the shoulders. In upper dorsal and cervical disease, the high plaster—the " Minerva " (*Fig.* 335)—is applied, supporting the chin and occiput. In all

cases the lower limits of the plaster are the symphysis pubis, the trochanters, and the lower part of the sacrum.

Since nothing but thin jersey material intervenes between the plaster and the skin, close apposition is obtained. This is accentuated by careful moulding of the jacket while still unset. The moulding is made at the lower end over the sacrum, above the iliac crests, and downwards in front to the top of the symphysis pubis. The chief *points d'appui* above are the lower aspects of the clavicles, and the mastoid and occipital regions. A notable feature is the large anterior window which is cut, allowing free respiration, and greatly reducing the weight of the jacket. Calot[5] points out that there is always a space between the skin over the spine and the plaster, however well applied, and in all cases a window is cut behind at the site of disease. The intervening space is then stuffed firmly with layers of

FIG. 336*a*.—RENÉ B., AGED 6½, DECEMBER, 1911. (Sketched from photograph.)

FIG. 336*b*.—RENÉ B., AGED 7, MAY, 1912. (Sketched from photograph.)

soft cotton-wool. The central portion of the plug projects from the window, and is pressed in by a few turns of starched bandage.

Where there is no deformity, this plug will prevent its occurrence. Where deformity is present, the plug will gradually reduce it in a remarkable fashion (*Figs.* 336*a* and 336*b*). I saw cases, and many photographs of cases, showing the complete removal of deformities, sometimes even in patients with long-standing disease. This method is particularly valuable in dorsal disease, where hyper-extension is not permissible and where deformities are naturally more obvious from the direction of the physiological curve. Cases with paraplegia are similarly treated and usually recover. The cotton-wool plugging often brings improvement within a few hours.[5] Ménard's operation of costo-transversectomy seems to have been an improvement on previous methods of access in cases of paraplegia, but he has now abandoned it in favour of mechanical treatment, owing to the frequent

persistence of sinuses. The treatment of spinal abscess is referred to later. Ménard[6] gives a much longer duration to the disease than that commonly accepted in England. He states that repair does not begin till the third year, and that three years is the minimum course in children, while in adults the duration is ten to fifteen years. The latter gloomy statement is partly set off by another, viz., that the disease in adults is usually not diagnosed for about eight years from its inception. In the convalescent stage, especially in high disease, the patients are allowed to walk about in the Minerva plasters. Later, celluloid jackets of the same design are used.

FIG. 337.—EARLY STAGE OF SPINAL CARIES.

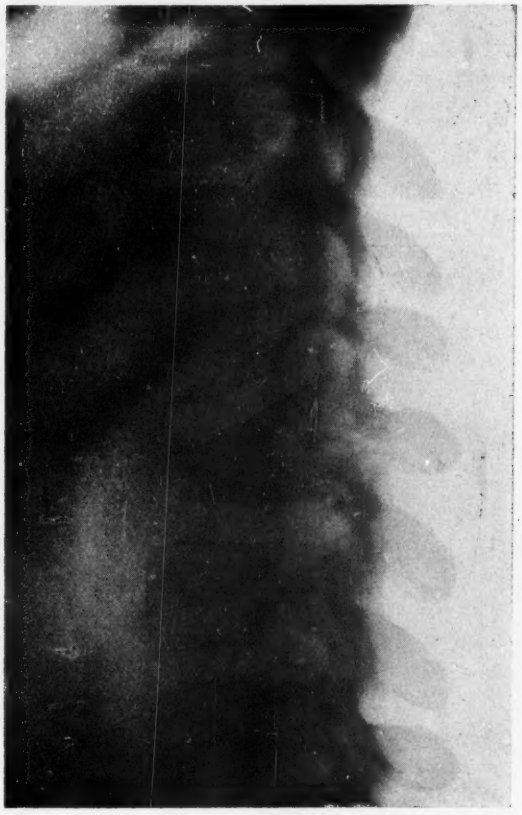


FIG. 338.—A HEALED CASE OF SPINAL CARIES.

Figs. 337 and 338 are examples of the numerous excellent skiagrams which are taken. *Fig.* 337 illustrates an early stage of the disease, in this case shown chiefly by the thinning of the intervertebral disc. *Fig.* 338 shows a healed case. Though two bodies are largely destroyed, there is, by means of treatment, very little deformity, owing to the formation of compensatory curves close to the lesion, and pressure atrophy of the posterior elements of the column at the site itself.

HIP JOINT.

Here again, conservative treatment reigns supreme. I saw several cases discharged, some with good movement, all in good position, that aimed at being one of abduction with internal rotation. The functional results when ankylosis occurs are much superior if the foot turns in slightly.

The usual routine is :—

1st Year.—Recumbency, with use of the large plaster, including the pelvis and the foot. Where vicious position is present, this is corrected by a series of plasters, slight additional correction being made with each change. The desired position is obtained in a few months.

2nd and 3rd Years.—Extension with abduction and internal rotation.

After this, the patient is allowed to walk in a middle plaster, leaving the foot free, and later in a celluloid splint of similar design. Calvé has lately designed a most ingenious extension apparatus which he claims to fulfil all the desiderata (*Fig.* 339). The limb is enclosed as little as possible to avoid undue wasting, the grip

FIG. 339.—CALVÉ EXTENSION APPARATUS FOR TUBERCULOUS HIP JOINT.

of the thigh being made principally by springs which fit over each condyle. The degree of inversion is regulated at a disc beyond the foot. On each side of the foot are weighted boxes retaining the apparatus and the limb in the desired position, and the whole slides on a board inclined towards the pulleys and extending weight. The patient is shown lying on one of the wooden trays, which permits of easy transport from place to place.

In other cases, a useful wooden foot-splint is applied, which encloses and protects the foot, and prevents foot-drop. The foot is fixed to the splint, to which also the extending weight is attached.

With the treatment described later, sinuses are rare. When these have

already occurred with a mixed infection, a limited excision for drainage purposes is frequently performed. This consists of removal of the head of the femur through the usual anterior excision, rendered T-shaped by a right-angled backward cut, and allows of free drainage of the joint cavity.

Bilateral radiograms are taken every few months, printed, and attached to the notes of the case. These illustrate every stage of the disease, viz: (*a*) The early stage, where disease is shown merely by thinning of the upper part of the cartilage; (*b*) The middle stage, with general haziness of outline; (*c*) The late stage, where cure is indicated by the density of the shadows cast by the sclerosed bone surrounding the articulation.

Fig. 340 shows a "middle" plaster, i.e., reaching the calf, applied in the convalescent stage, and illustrates well the moulding round the knee and the pelvic brim.

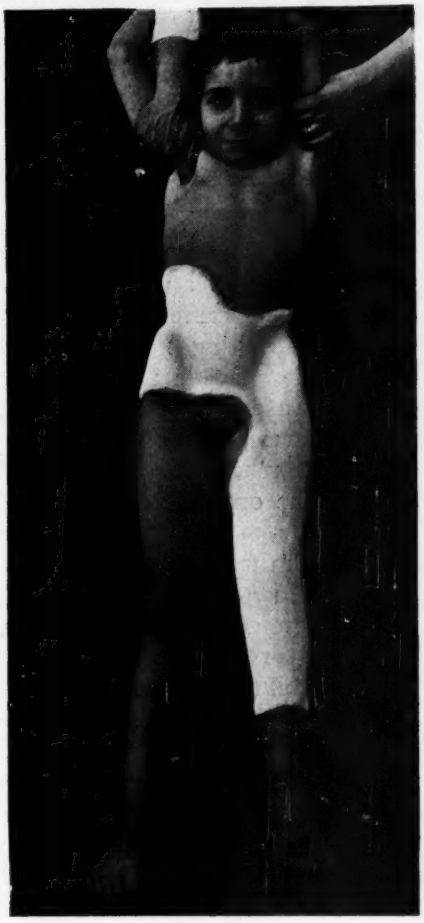


FIG. 340.—A MIDDLE PLASTER FOR A CONVALESCENT PATIENT.

KNEE JOINT.

Treatment is by recumbency in plaster, including the pelvis and foot. Flexion is corrected by extension apparatus or by a series of plasters. Subluxation is corrected — under anæsthetic — by pulley extension combined with manipulation. The limb is then put in plaster, and windows are cut in front of the lower end of the femur and behind the head of the tibia. Compression by cotton-wool plugs then completes and maintains the reduction. Excision is almost entirely reserved for cases in adults where a stiff joint is inevitable.

ANKLE JOINT.

The prognosis of tuberculous ankle joint under conservative treatment is considered to be less good than in most other regions. Operation is resorted to more frequently. Astragalectomy is the usual procedure, and the results seem to be satisfactory.

ABSCESS OF BONY ORIGIN.

The incision of a purely tuberculous abscess is looked on as a surgical crime. Even when the wound is carefully sutured, a track is said to remain whereby a sinus will open sooner or later in most cases.

Aspiration is the method of choice, and this is done before the skin is threatened. The technique consists briefly in oblique puncture through sound tissues well to one side of the abscess, and that not the most dependent. In cases of psoas abscess, the skin is drawn inwards before puncture, so that when it slips back the point of puncture lies outside the anterior superior spine. In withdrawing the needle a vacuum is maintained, so that the tissues may be sucked together as the needle leaves them. Sinuses are extremely rare with these precautions. Modifying fluids such as thymol-camphor or " huile iodoformée," with well-known formulæ, are much used.[7]

Parenthetically, it may be noted that Calot has revived intra-articular injections apart from the presence of abscess, and claims good results.[5]

TUBERCULOUS GLANDS.

When these have passed to abscess formation, puncture and injection are used very much in the same way as in abscesses connected with bone disease. This treatment is also applied to glands in the earlier stages of softening, the caseous material being modified by thymol-camphor injections and the resulting fluid débris drawn off a few days later. This method is chiefly applicable to small numbers of large glands, or to specially large glands in a group of all sizes. Where there is general enlargement of glands, in the cervical group for example, excision may be practised, or general treatment relied on. Perfect results without scarring or sinuses are to be seen as the outcome of puncture and injection.

To sum up the treatment of tuberculosis at Berck, it may best be described as radical conservative treatment; that is to say, radical cures by conservative methods are aimed at and very often reached. Such principles involve long and careful supervision as in-patients, cases remaining if need be for several years, in fact, until they are cured where cure is possible.

This is the logical and ideal treatment, and we in England know to our sorrow how far and frequently we fall short of this ideal in our general hospitals through exigencies of space.

It must not be thought that surgical tuberculosis is the only disease treated at Berck. There are many cases of congenital syphilis of bones and joints where the differential diagnosis has to be made. Rickety deformities are also seen, but they appear to be mild, at least compared with those of our large manufacturing centres. General orthopædic surgery is also largely practised, and good progress is being made in the treatment of scoliosis by Abbott's method of overcorrection in plaster. I saw many cases.

Owing to the wide field covered, the above is necessarily a sketch of the briefest nature of the work that is being done just across the Channel.

As regards the hospitals themselves, they are run on the usual lines of such institutions in France. They are all equipped with theatres devoted to manipulative and plaster work in addition to the operation theatres. Usually a special day is set aside each week for the application of plasters.

In conclusion, I would wish to express my thanks for the courteous and kindly treatment extended by all to one with a very imperfect knowledge of the

language, and especially to Dr. Calvé for the assistance he has given me and for the photographs which he has so kindly put at my disposal for the purpose of illustrating this article.

REFERENCES.

[1] GAUVAIN, The Use of Plaster of Paris in the Mechanical Treatment of Tuberculous Disease of the Spine. *Practitioner*, Jan., 1913.

[2] GAUVAIN, The Use of Celluloid in the Treatment of Tuberculous Disease of the Spine. *Brit. Med. Jour.*, June 7, 1913.

[3] CALVÉ, Traitement du Mal de Pott. *Journ Méd. Français*, Dec. 15, 1912.

[4] LELIÈVRE, Le Traitement Orthopédique du Mal de Pott. Jouve & Cie., Paris, 1912.

[5] CALOT, Orthopédie indispensable. Maloine, Paris, 1913.

[6] MÉNARD, Etude Clinique sur le Mal de Pott. Masson & Cie., Paris, 1900.

[7] CALVÉ AND GAUVAIN, The Treatment of Tuberculous Abscesses of Bony Origin by Conservative Methods. *Lancet*, March 5, 1910.

INSTRUCTIVE MISTAKES.

CASE 13.

DUODENAL ULCER AND RUPTURED TUBAL PREGNANCY, IN WHICH THE PREGNANCY WAS OVERLOOKED.

THE patient was a married woman, aged 28.

Previous History.—For many years had suffered from indigestion, i.e., pain in upper abdomen, with flatulent distention after food.

Menstrual History.—Two pregnancies, nine and seven years ago. For last seven years menstruation regular to a day, lasting seven days, with twenty-eight-day interval. Dysmenorrhœa on first day of every period. The period due in the first week of August, 1913, appeared at the right time, and resembled her ordinary periods in every way except that it lasted fourteen days instead of seven. Pain in back on first day of period as usual. Blood bright red, without clots.

Present Condition.—Seen on September 4. Patient very intelligent, and markedly anæmic. This was said by the mother to be her daughter's normal colour. For the last forty-eight hours has had diarrhœa and vomiting, preceded by generalized abdominal pain, which has since subsided. Much flatus is being passed by mouth and per rectum. Breasts flaccid. Patient is certain that she is not pregnant. Pulse 120. Temperature 102°.

Abdomen.—No marked distention. No boarding. No abdominal dullness. No pain. No tenderness on deep palpation. Percussion note tympanitic, most marked over the stomach.

Per vaginam.—Cervix fixed, pointing forwards and not softened. Bright blood, free from clot, was issuing from the vagina. The patient considered this to be her normal period, which was due.

Per rectum.—A smooth, immovable, rounded body, the size of a golf ball, was felt through the anterior rectal wall, and was regarded as the uterus. On deep pressure to the right of this body, moderate pain was experienced. No pelvic swelling, other than the above, was palpable.

Chest.—Nothing abnormal.

Seen again in consultation two days later, the condition was very little changed. The pulse, temperature, and pelvic condition were as before. The diarrhœa and vomiting had ceased. On deep respiration the movements were almost entirely costal, the diaphragm hardly moving.

A blood-count showed leucocytes 19,000, red cells rather less than 2,000,000.

A tentative diagnosis of a leak from a gastric or duodenal ulcer, with sub-diaphragmatic abscess, was made. Prior to operation, 3 pints of saline solution were absorbed per rectum.

Operation.—(Sept. 7). Epigastric incision. Black liquid blood, under great tension, poured out. Stomach normal. On the posterior wall of the duodenum, one inch from the pylorus, was a thick nodule, half an inch in diameter. The hand, passed towards the pelvis, encountered masses of soft blood-clot. The incision was extended to the pubes. The fixed and retroverted uterus could not be delivered. There was no blood in the broad ligament. The right Fallopian tube, ragged and covered with adherent clot, was doubly ligated and left in situ. Gauze was packed down to this area and brought out above the pubes. There was no active bleeding during the operation. Among the removed clots was a spherical mass, two and a half inches in diameter, containing an amniotic cavity. No fœtus was seen. At the end of the operation the pulse was 160, and the extremities were warm. Under saline solution, given by rectum and the axilla, the pulse dropped to 120 and the temperature rose to above normal. For thirteen hours this rally was maintained; then the heart rapidly failed, and death occurred eighteen hours after operation.

Comments.—A correct diagnosis, prior to operation, was not made The question of tubal pregnancy was raised and dismissed. The menstrual history given by the patient was false. After the death of the patient, it transpired that she had considered herself three months pregnant, and had for some weeks been taking drugs in order to produce a miscarriage. The anæmia resembled that of sepsis, and in no way suggested blanching due to a large loss of blood. The appearance of bright fluid blood free from clots in the vagina, at a time when the period was said to be due, appeared to corroborate the menstrual history given by the patient. The only faintness was that said by the relatives to have accompanied some of the attacks of vomiting. Although frequently visited by two medical men, nothing approaching a faint was ever observed. There was neither restlessness nor air-hunger. No pelvic tumour was palpable, and the broad ligament was not involved, the tube having ruptured into the general peritoneal cavity. The abdomen, filled with blood, sufficient in amount to reduce the red cells to 2,000,000, and sufficiently infected to cause a leucocytosis of 19,000, was devoid of tenderness. Assuming some drug, such as lead, to have been taken in large quantities, such poisoning would, to some extent, explain the initial colic and anæmia, and might possibly have contributed to the fatal issue.

Case 14.

MELANOTIC SARCOMA MISTAKEN FOR AN INNOCENT TUMOUR. A GRAVE ERROR IN PROGNOSIS.

C. V., a married woman, aged 41, was admitted to hospital for a growth in the palm of the hand.

History.—She had had a warty growth on the hand ever since she could remember. For several years past this had steadily enlarged. For some months it had become sore, and latterly offensive.

Present Condition.—Rather pale, but well-nourished woman. The left hand presented the tumour shown in *Figs.* 341 and 342. It was about the size of a small orange, lobulated, and all the surface was ulcerated and sloughing; the

discharge was both copious and offensive. The base of the growth was broad, and corresponded to the palmar surfaces of the three middle digits. There was some ulceration extending from the base round the outer aspect of the index finger. Enlarged glands were present on the inner side of the elbow and in the axilla.

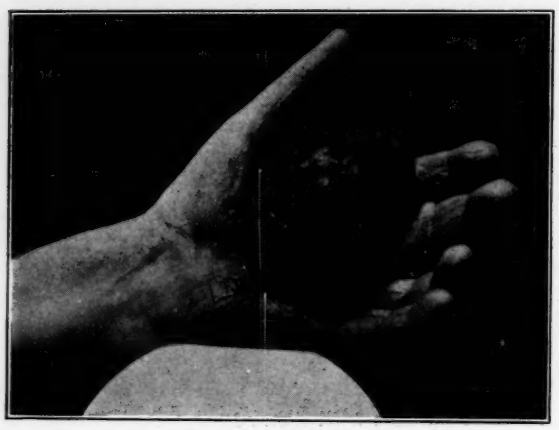


FIG. 341.—THE HAND OF THE PATIENT. The tumour forms a firm globular mass in the palm.

The parts were so foul that some days were spent in cleaning them by means of fomentations. Then, under an anæsthetic, a piece of the growth was removed from its most prominent portion, and submitted to the pathologist. He reported the growth to be an innocent "adenoma sebaceum," and the micro-photograph in *Fig.* 343 leaves no question as to the accuracy of this opinion. The septic state of the hand was quite enough to account for the enlargement of the glands.

The patient and her husband, who were anxious to avoid operation unless there was a good prospect of permanent recovery, were told that the growth had no tendency to malignancy, and that its removal would be attended by a cure. Under these circumstances they consented to the operation (July 18, 1913), which consisted in an amputation of the four fingers with their metatarsal bones, the thumb being left. At the same time, one of the epicondylar glands was removed.

When the growth had been hardened and cut open (*Fig.* 344), it was seen that in the overhanging margin of the growth, towards the wrist, there was a distinct black nodule. Both this and the excised gland were indubitably melanotic sarcoma, with the usual alveolar structure (*Fig.* 345).

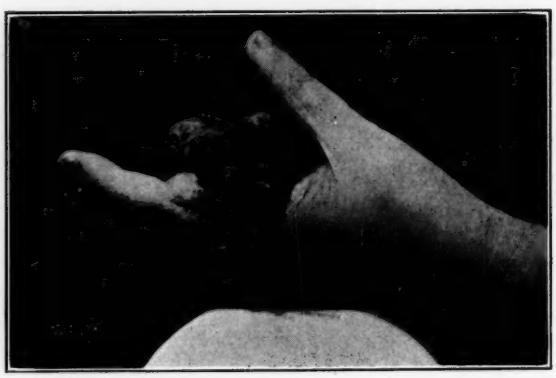


FIG. 342.—The same as Fig. 341, showing a shallow ulcer creeping on to the back of the index finger.

The patient returned home, refusing to have the glands removed from the axilla.

After History.—The patient took to her bed after leaving the hospital, and from it she never rose, dying on November 23, 1913, four months after the operation. I visited her once at her home (Oct., 1913), but could not determine the exact nature of her illness. There was no recurrence of the growth either

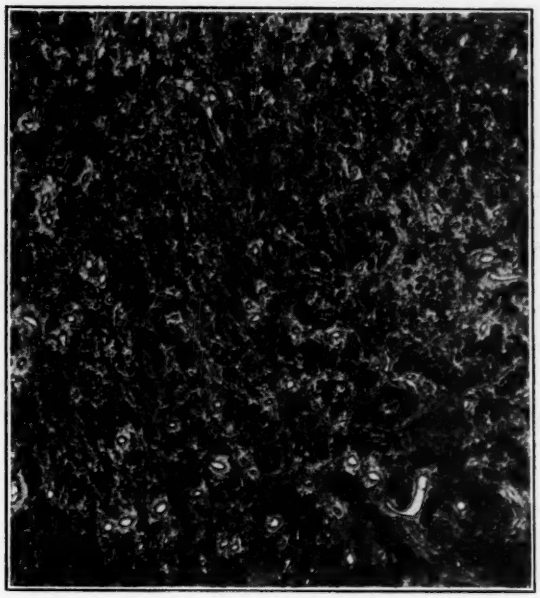


FIG. 343.—Section from the prominent portion of the tumour, showing a perfectly innocent type of sebaceous adenoma.

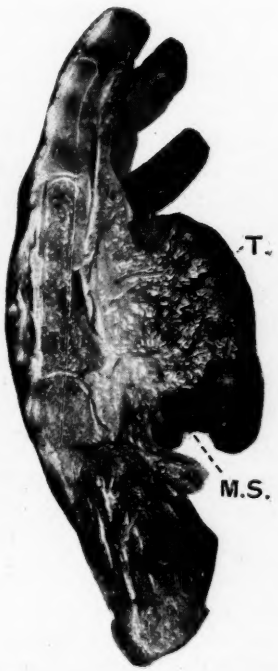


FIG. 344.—The amputated portion of the hand cut down the index finger, showing the patch of melanotic sarcoma (M S) in the lower margin of the tumour (T).

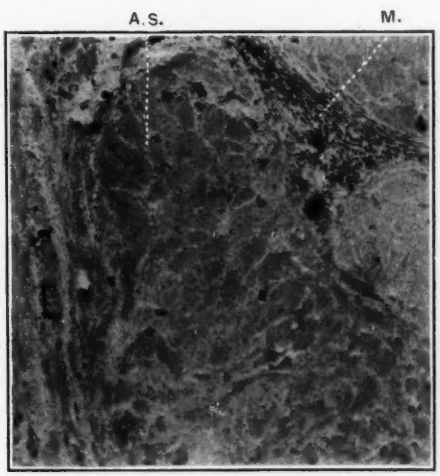


FIG. 345.—A section of one of the epitrochlear glands, showing the structure of an alveolar sarcoma (A.S.), with patches of melanin (M) scattered throughout its substance.

in the hand, elbow, or axilla, where the glandular masses, though enlarged, were not much different from their former condition.

Her chief complaints were abdominal pain, and weakness of the legs. These, associated with great tenderness over the lower dorsal and lumbar spine, lead to the suspicion of a secondary growth in the vertebral column.

Remarks.—The fact of this tumour having been preceded by a warty growth which had always been present, ought to have suggested the idea of a pigmented mole causing melanotic sarcoma.

It was not practicable to remove the whole growth (without amputation of the fingers) for microscopical examination, because a large part of the palm of the hand would then have been laid bare.

No case could possibly illustrate better the limitations and fallacies of deductions made from the pathological reports on small pieces of tumours. No pathological report of a growth that is founded on less than a complete series of sections of the entire growth can prove its innocence.

Case 15.

AN AXILLARY ABSCESS MISTAKEN FOR A SARCOMA.

S. H., a strong and healthy railway porter, aged 36, was sent in to hospital with a diagnosis of a tuberculous abscess of the axilla.

In the left axilla was a firm elastic swelling, about 4 in. diameter, occupying the posterior fold of the axilla and closely connected with the axillary border of the scapula.

The onset had been of only a few weeks' duration. Its firm texture and the close connection with the bone were strongly suggestive of a sarcomatous growth, and it was therefore decided to determine the diagnosis by an exploratory operation. This was done, and on incising the swelling nothing escaped but blood and broken-down tissue. A piece of the more solid part of the swelling was excised and sent to the pathologist, and the wound was sewn up. The pathological report was made from a fresh frozen section, and it stated without any equivocation that the growth was a sarcoma. After waiting a week for the exploratory wound to heal, a further operation for the radical removal of the supposed growth was undertaken.

Fortunately, only a partial excision of the scapula was done, as it was found that by cutting wide of the growth it could be completely excised without going higher than the scapular spine.

An ample area of skin and all the muscles (latissimus dorsi, serratus magnus, rhomboideus major, subscapularis, and infraspinatus) attached to the lower part of the scapula were removed, by cutting these tissues at a distance from the mass. The scapula was sawn through just below the spine. The skin came together well, and healing was normal and rapid.

A subsequent dissection of the specimen, with further microscopical examination, proved it to be a chronic abscess in the subscapular lymph glands. Nothing resembling tubercles was found, but the greater part of the wall consisted of small round-celled infiltration of lymphoid tissue, mingled with a good deal of fibrous tissue.

The portion on which the wrong diagnosis had been founded consisted of just that mixture of round and spindle cells which might indicate a sarcoma.

The subsequent history of this case is of interest, as showing how little disability may result from an extensive operation such as that described. The patient was examined recently, nine months subsequent to the operation. He had returned to light work within six weeks, and within three months of the operation he could resume his full work as a railway porter, which he has continued uninterruptedly ever since.

Case 16.

A SARCOMA MISTAKEN FOR AN ABSCESS.

The error of diagnosis indicated by the title is one not infrequently made. The mimicry of an abscess by a sarcoma is sometimes so extraordinarily close that the differential diagnosis becomes very largely a matter of guesswork.

The opposite mistake—calling an abscess a sarcoma—is probably only less frequent, in that an abscess is a far commoner lesion than a sarcoma. Most red, tender, fluctuating swellings are abscesses, and therefore the possibility that a particular case may be an exception to the rule is apt to be overlooked, and prove a trap for all but the most wary.

A feeble old man, aged 73, was seen with a red, tender, fluctuating swelling in the left axilla, which he had noticed for the previous three weeks. There was also some infiltration, apparently inflammatory, under the pectoral muscles. It was therefore diagnosed as an acute abscess, and opened with very simple preparations; blood, instead of pus, filled the cavity, and the swelling proved to consist, to all appearances, of breaking-down growth. So alarming was the hæmorrhage that the operator was compelled to tie the axillary artery.

Microscopical examination proved that the tissue removed was a spindle-celled sarcoma. Nothing short of a forequarter amputation—if even that—could have completely got rid of the growth, and the patient's feeble condition put that out of the question. A course of injections of Coley's fluid was given, but no benefit resulted.

Meanwhile the circulation in the arm was very poor, and gangrene became definitely established in the forearm. The muscles, front and back, sloughed, and a condition of moist gangrene extending nearly to the elbow ensued, with considerable infiltration in the lower part of the upper arm.

A circular amputation was performed through the middle of the arm. No tourniquet was used, but the hæmorrhage from the shrunken brachial artery was very slight. The wound healed by first intention, and the patient was quite well when last seen, despite the fact that the growth is slowly extending.

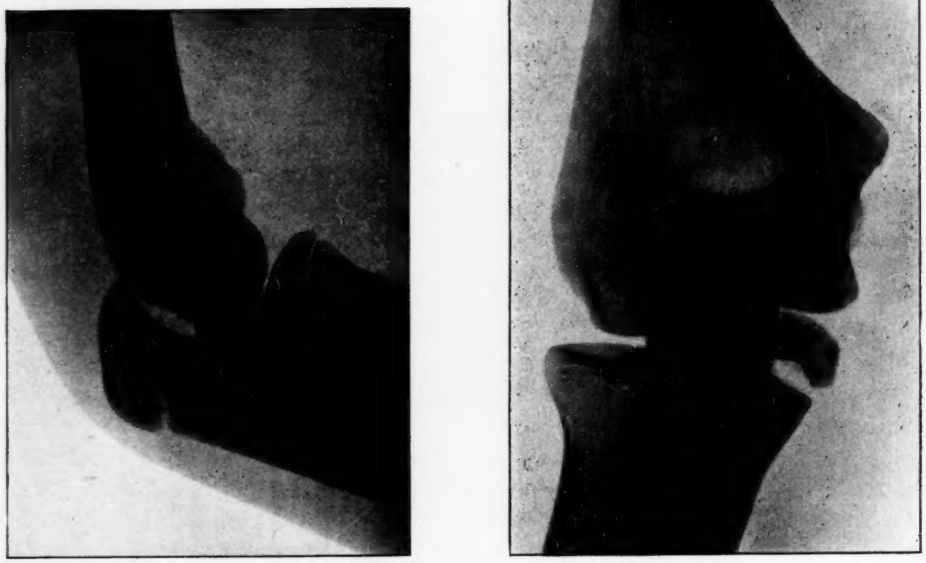
The collateral circulation in the arm being so free, it is somewhat surprising that gangrene followed ligature of the axillary artery, unless the vein was wounded or tied at the same time. The old man's general circulation, was, however, very sluggish, and it is possible that the axillary vein was obstructed or obliterated by the growth.

SHORT NOTES OF RARE OR OBSCURE CASES.

SEPARATION OF EPIPHYSIS OF THE INTERNAL CONDYLE OF THE HUMERUS, WITH DISPLACEMENT INTO THE ELBOW JOINT.

By C. W. G. BRYAN, London.

J. W., a boy aged 14, came to St. Mary's Hospital on July 1, 1913, for an injury of the right elbow, sustained in falling from a see-saw ten days before. He thought the elbow struck the ground, and he heard a crack, but could not say what was the exact position of the limb at the time. Afterwards, he had little pain, but was unable to straighten the limb fully, though within a week he could use it for gardening.



Figs. 346, 347. Skiagrams showing Separation of Epiphysis of Internal Condyle of Humerus, with Displacement into Elbow Joint.

On examination, a small bruise was found in relation to the inner aspect of the elbow joint, and a little fullness under the tendon of the triceps muscle. The internal condyle was absent from its normal position, and the bone here was rough and slightly tender. Flexion of the elbow was 20° less than normal, and

extension was 30° less than normal; pronation was normal, and there was slight limitation of supination, passive attempts to supinate the forearm fully causing pain in the region of the pronator radii teres muscle.

Skiagrams (*Figs.* 346, 347) were taken by Dr. Harrison Orton, and showed that the internal condyle had been detached and displaced into the elbow joint, and was lying, with its fractured surface downwards, between the trochlea and the articular surface of the ulna.

On July 4, Mr. Warren Low operated, making a vertical incision on the inner aspect of the elbow. It was found that the detached fragment had passed through a well-defined small hole in the internal lateral ligament, taking the muscles arising from it as a flap. The fragment was excised after being hooked out of the joint, which contained no blood or excess of fluid: the muscle origins were sutured to the periosteum at the margin of the rough area, from which the epiphysis had been broken off. The detached fragment consisted of the epiphysis with a small flake of bone from the diaphysis.

The boy was again seen on August 15. He considered his arm as well as before the accident, and indeed had a good functional result. Full flexion, pronation, and supination could be obtained, but extension was 20° less than normal.

The case is of interest on account of: (1) The small amount of bruising, limitation of movement, and disability which followed the accident; (2) The unusual nature of the displacement: I have been unable to find any record of similar cases.

I wish to express my thanks to Mr. Warren Low for permission to publish these notes.

TUBERCULOUS DISEASE OF THE OS CALCIS.

By GRAHAM SIMPSON, Sheffield.

I have read several articles on septic osteomyelitis of the os calcis, but have not yet come across a clear account of primary tuberculous disease of this bone; yet, judging from the only case I have seen, the clinical picture of this affection is rather a striking one. In its early stage, this condition closely resembles a minor degree of talipes equinus, and a mistake in the diagnosis, as in my case, will lead to incorrect treatment, which will probably aggravate the disease.

The notes of my case are as follows:—

Lily Y., aged 8, was sent to me by Dr. Saunders, of Wales, because she "turned in the left foot and walked very lame;" this had been noticed for three months; she occasionally complained of a little pain in that ankle.

When I saw her, there was no limp, and the foot looked normal; there was no tenderness of the foot, and the ankle, knee, and hip joints were all healthy; I could find nothing wrong with the spine.

All I could find amiss with the left leg was three-quarters of an inch wasting of the calf, and a right-angled equinus. I came to the conclusion that she had suffered from an unobserved infantile paralysis, and was developing talipes equinus, and I ordered her to have a course of massage and electricity.

Five weeks later, she was again brought to see me ; there was now obvious swelling and tenderness of the left os calcis ; she was unable to flex that ankle joint to a right angle, and stood with that foot advanced ; there was also a marked limp.

An *x*-ray photograph was taken (*Fig.* 348), and showed a clear space in the os calcis, just beneath the insertion of the tendo Achillis. At the operation, a cavity was found in the bone which was full of pus and œdematous granulation tissue ; it was the size of half a walnut. The cavity was scraped out and the skin sutured over it without drainage. The wound healed by primary union, and a plaster-of-Paris bandage was applied before sending her home. Four months after the operation the foot is still quite well.

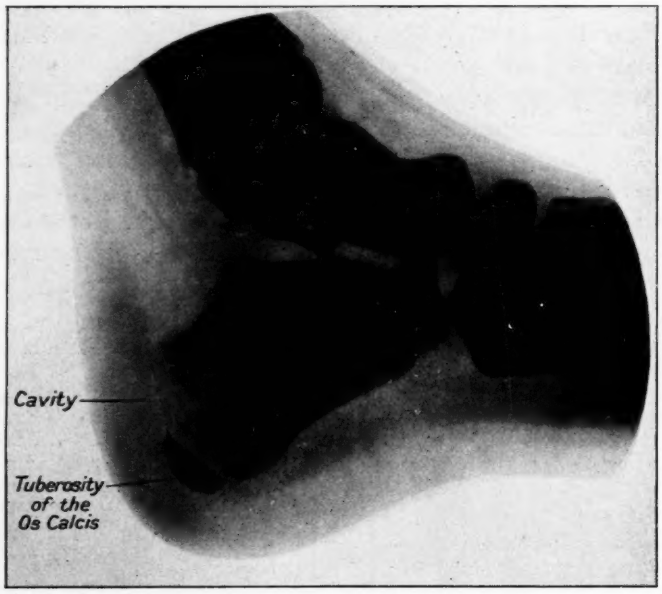


FIG. 348. TUBERCULOUS DISEASE OF THE OS CALCIS.
Note the obvious cavity in the bone, and the tuberosity of the os calcis.

In this case, as the skiagram shows, the disease started as an epiphysitis under the tuberosity of the os calcis, and the clinical picture appears to depend on the pull of the tendo Achillis on that part of the bone. This will explain the *early limp* (which the parents stated was always *worse after exercise*), the *difficulty in flexing the ankle joint*, and the typical attitude with the *foot advanced*. The wasting of the calf muscles would, I think, occur with tuberculous disease of any other part of the tarsus or of the ankle joint.

I believe that primary tuberculous disease of the os calcis is very uncommon, and therefore mistakes in diagnosis are likely to occur and lead to wrong treatment. Perhaps the best way to prevent this is to have an *x*-ray photograph taken in any case of early talipes equinus with a doubtful history.

The skiagram was taken for me by Dr. W. H. Nutt.

UNUSUAL DISPLACEMENT OF INTESTINES.

By ALEXANDER DON, Aberdeen.

J. M., a girl of 19 years, employed as a bottler, came under my care in the Dundee Infirmary, in October, 1912. She had suffered from pains in the upper abdomen for two months. The pain was brought on by taking food, and relief was obtained by vomiting. The vomit did not contain blood. The first attack lasted for eight days, after which she seemed quite well again. A week later she had a similar attack, but did not vomit. Just before I saw her she had attacks of pain every day after eating, colicky in nature and subsiding gradually, either after or without vomiting. Her doctor suspected gastric ulcer, and sent her in for operation.

There had been no previous abdominal trouble, though she had noticed a rumbling on the left side after meals. There had been no pain. Her mother had suffered from stomach trouble before marriage, but not since. There were six in the family, three sisters and two brothers, all healthy.

Circulatory System.—The patient looked healthy, and was well nourished. Her extremities were blue, but not cold or congested. The blueness disappeared with rest, and was attributed by her to the damp nature of her occupation. Circulation otherwise normal, and heart not displaced.

Respiratory System.—This was described on admission as normal, with the exception of a few râles (?) at the left base, where there was a small dull area. There was no breathlessness, even during the attacks of pain, and the pain was never in the chest.

Alimentary System. — Tongue coated, breath foul. The abdomen was flat, and the muscles held tight, but not with the rigidity of peritoneal inflammation. This made examination difficult, but there was no pain on firm pressure, except over the bile-passages, and a small area to the left. There was no tumour visible or palpable. The right kidney was easily felt, and was freely movable. By auscultation-percussion the stomach reached the umbilicus. The stomach contents contained free HCl, but no organic acids. Rennin, albumoses, and pepsins were present. Microscopically, there were no unusual organisms. Radioscopically, the stomach reached the symphysis in the upright, and the umbilicus in the prone position. The pylorus and duodenum were seen to the right and above respectively, and peristalsis of the stomach was fairly active. A plate, taken with the patient standing, shows all the bismuth meal within the true pelvis. Unfortunately, the further progress of the bismuth was not observed. In a plate of the upper abdomen and chest, there is nothing abnormal seen. Menstruation was regular and painless.

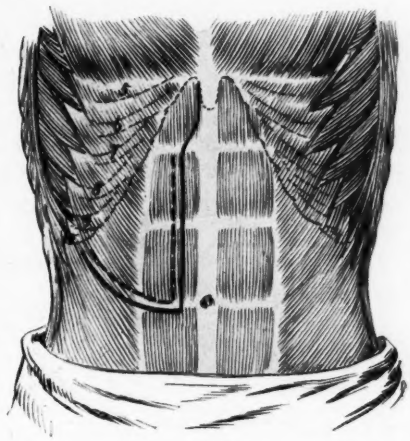


Fig. 349.—The Abdominal Incision.

The interrupted line is that of the posterior part of the incision, and lies directly beneath that of the anterior incision. The ends of the vertical part of the anterior incision may be prolonged upwards to the left of the ensiform cartilage, and downwards towards the iliac spine of the same side.

Operation.—As no definite diagnosis could be agreed upon, I opened the abdomen by the method I described in the *British Medical Journal*, in March, 1909. The incision is shown in *Fig.* 349. I have used this incision for years, and find it specially convenient for doubtful cases in the upper abdomen, or for operations on the biliary tract. Healing and feeling are perfect. The vertical incision is made first, and the horizontal only when shown to be necessary after actual examination of the abdominal contents.

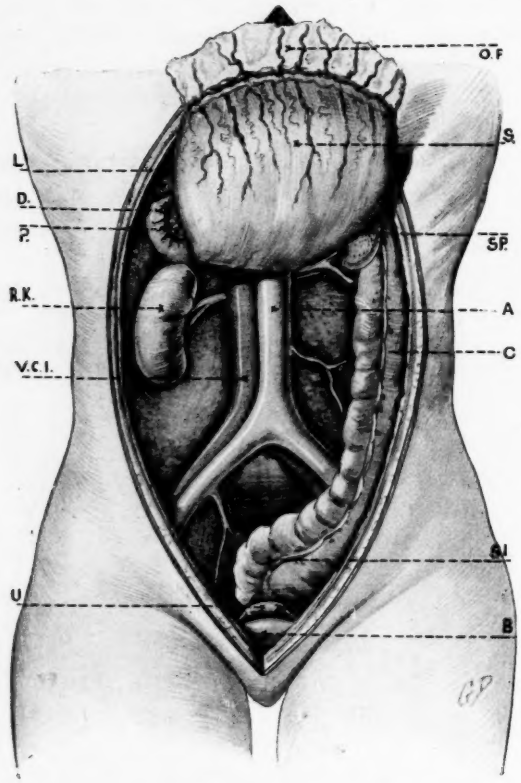


FIG. 350.—DIAGRAMMATIC VIEW OF THE ABDOMINAL ORGANS.

L, Liver; D, Duodenum; P, Pancreas; RK, Right kidney; VCI, Inferior vena cava; U, Uterus; B, Bladder; SI, Sigmoid; C, Colon; A, Aorta; Sp, Spleen; S, Stomach turned up; OF, Omental fringe. (The spleen and upper part of the descending colon were not so clearly exposed, nor their relations as evident as shown in the diagram.)

This incision, with a slight modification, which had been tried in some dozen cases by Perthes before publication, was strongly recommended by Gray, in the October issue of this Journal, for surgery of the biliary organs. Prof. Perthes, I was told, was interested in my incision when its description appeared, and seems to have used it without alteration for a long time. The change he suggests I had tried and abandoned, as it spoiled the primary object of the incision, which was to preserve the nerve supply to the *peritoneum* as well as to the skin and muscle.

The liver presented as usual, and there was a long Spigelian lobe reaching to the umbilicus. The biliary apparatus was free from disease. The upper border of the stomach was below the general liver margin, owing to an unusually long small omentum. The duodenum was hung up to the liver by a fibrous membrane, and its second part turned upwards behind this membrane to disappear under the small omentum. The pylorus was dilated, and measured about 2 in. across. The stomach was now pulled outside. It was a very wide bag, as represented in *Fig.* 350, and was suspended from its two upper ends like a Highland sporan, by the cardiac and pyloric straps. The great omentum was represented by the fatty fringe seen in the figure, and there was no transverse colon attached. The lower abdomen seemed entirely empty, and I continued the incision downwards to examine the pelvic organs. There was about an ounce of a blood-stained, jelly-like substance in Douglas' pouch. The pelvic colon and pelvic genitalia were normal. There were no small intestines or trace of mesentery.

The right kidney was covered by peritoneum, and was abnormally movable. The descending colon issued from below the peritoneum to the left of the stomach. The peritoneum was reflected from the posterior abdominal wall, at the origin of what I took to be the superior mesenteric artery, as a branch went to supply the descending colon (A. colica *media*). Thinking that the short small intestine might join the colon behind the lesser omentum, I followed the duodenum upwards behind the suspensory membrane and lesser omentum, uncovering a part of the pancreas in the duodenal concavity, but had to desist on account of hæmorrhage. The colon was next followed upwards, and the lower end of the spleen came in sight, but here again I was ultimately checked by hæmorrhage. The case seemed to be one of congenital shortness of the intestine, or retained embryonic simplicity of the loops and coils of the bowel.[1] Along with, and probably caused by, this shortness, had occurred a curious twisting of the mesentery, so that the primitive coil of bowel, after its return within the abdominal cavity (*Fig.* 351), had passed along the left side of the mesogastrium to lie behind the stomach when the latter assumed the adult position.* This would carry the posterior mesogastrium up, and apply it to the right or posterior surface of the anterior mesogastrium, which encloses part of the liver-bud, and ultimately forms the lesser omentum. There would be no lesser sac or omental bursa, and no foramen of Winslow. Fusion of peritoneal surfaces would take place where these were in contact with one another or with the posterior abdominal wall. The fringe of omentum would grow down as usual from the greater curvature of the stomach. Thus would be produced the peculiar bag-like stomach represented in *Fig.* 350.

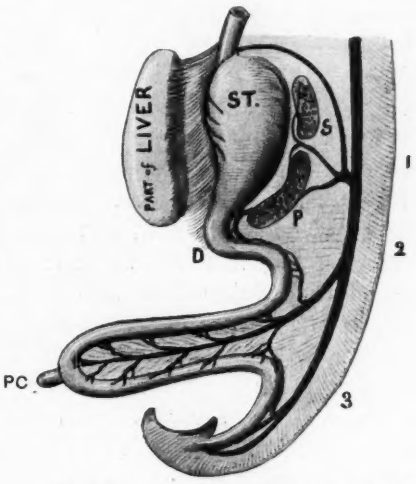


FIG. 351.—HUMAN EMBRYO OF SIX WEEKS (AFTER TOLDT).

ST. Stomach. D, Duodenum at caudal end of ventral mesogastrium. S and P, on dorsal mesogastrium opposite spleen and pancreas respectively. Aorta with 1, 2, 3, cœliac axis, superior and inferior mesenteric arteries. PC, Yolk-stalk of primitive coil.

If the intestine had passed at the same time up through the still patent communication between the pleural and peritoneal cavities, there would have been a condition of transdiaphragmatic hernia. There were few, if any, real signs of this condition. There may have been some defect in the diaphragm, caused by the interference of the misplaced intestine with the development of the pleuroperitoneal membrane, which normally grows from the dorso-lateral part of the body wall to fuse with the edge of the primary diaphragm, and thus separate the pleural from the peritoneal cavity. As hernia did not occur to me while operating, the posterior part of the diaphragm was not specially examined,

* This is the usual torsion that takes place, but the shortness of the intestine and the position assumed prevented the usual ventral crossing of the small by the large intestine.

but an opening would not have been easily detected, so adherent was the small omentum to the structures behind. Though nothing was done to relieve the pains, there were no more attacks during her stay in hospital. Nothing very definite was made out by further examination of the thorax posteriorly, though intestinal gurglings were occasionally heard below the scapular angle. There was nothing abnormal above this point. We arranged for a full *x*-ray examination, but the patient and her friends objected, and she was removed home. So far as I have been able to ascertain, she has been comparatively well since. The cause of the pains must have been an obstructive one, for there was no temperature during the attacks. The handy appendix would not be likely to be developed fully, so appendicitis is negatived.

In 1908,[2] I published a case of successful operation by gastropexy for diaphragmatic hernia in a man, aged 61 years, and reviewed the literature of the subject. Since then several monographs have appeared, but I have been able to find only one case at all resembling my own. This was a patient of W. J. Mayo. In his case the symptoms were very persistent, extending from the age of three months to the seventeenth year, when an exploratory operation revealed the condition. Nothing was done. Breath-sounds were absent on the left side, and vomiting was a prominent symptom, so that probably the intestines were more fully developed, and occupied the pleural cavity. Beckman, who published the case,[3] seems to lay stress on the tympanitic note in the chest. In the latest edition of "Bergmann's Surgery," it is stated that no operative treatment of diaphragmatic hernia has yet been attempted, and this is not surprising, as Lachner,[4] in a review of 266 cases, found only 7 in which a diagnosis had been reached during life. The stomach is the organ found most frequently in the chest, and to meet with it almost alone in the abdomen is very rare indeed. I am inclined to call this a case of embryonic shortness of the intestine, brought about by its anomalous position.

REFERENCES.

[1] Bailey and Miller, Embryology, 1909, 384.
[2] Don, *Edin. Med. Jour.*, 1908, Nov.
[3] Beckman, *Surg. Gyn. and Obst.*, 1909, Aug.
[4] Lachner, *Gaz. degli Osped. e delle Clin.*, 1897, Feb. 15.

NEW INSTRUMENTS AND APPLIANCES.

A TROUGH FOR EVACUATING INTESTINE.

By H. de L. CRAWFORD, Dublin.

The intestinal drainage trough figured below is designed to meet a need which has at some time presented itself to every operating surgeon. It is planned as an effectual means of quickly emptying intestine distended with gas and fæces, while preserving both the surgeon's gloves and the patient's peritoneum from contamination.

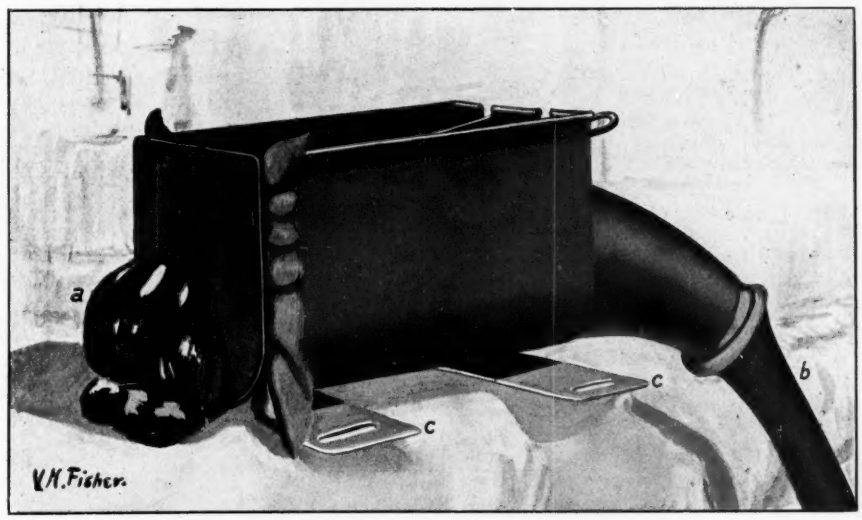


Fig. 352.—Trough in Position on Cadaver. (*a*) Cæcum drawn through rubber dam. (*b*) Tube running down over edge of table. (*c*) Support perforated for towel clip.

The apparatus consists of a metal trough, closed at one end by a strong rubber dam, and at the other leading into a funnel to which is attached a long piece of rubber tubing. Two long intestinal clips rest in notches cut in the wall of the trough, and the whole is supported on two flat plates of metal which are perforated at their ends. When required for use, the apparatus is boiled. It is then placed upon the patient's abdomen and upper thigh, so that the rubber dam is beside the wound, and is held by towel-clips fixing the perforated metal clips to the skin. The funnel and rubber tube lead over the side of the table into a bucket. A small hole is cut centrally in the dam, and the assistant presses a distended loop of bowel against this from the outside, so that a portion of the wall protrudes into the vessel. The operator then seizes this protrusion with the intestinal clips and secures it by slipping their handles into the notches, thus

stretching the rubber and providing a watertight contact. With a spare scissors a small longitudinal incision is made in the bowel wall, and the whole contents can be cleanly evacuated by gentle massage. This being accomplished, the clips release the gut, which can at once be wiped and sutured. Since the handles of the clips remain clean, while their jaws never leave the inside of the vessel, they cannot prove a source of danger, and if the surgeon will introduce the stitches with a needle-holder and tie them with forceps, he runs no risk of infecting his gloves.

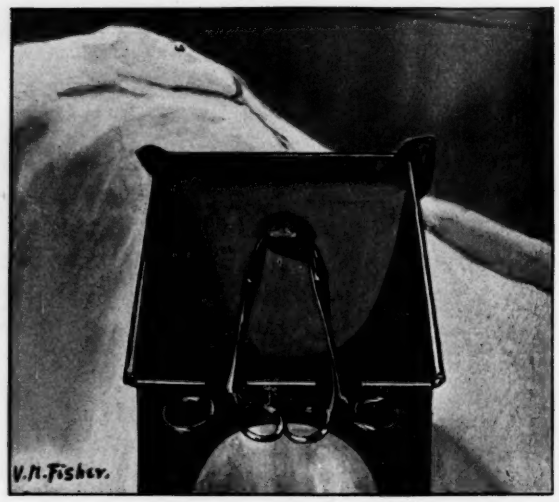


FIG. 353.—Inside view of trough, showing intestinal wall held in position by forceps. Intestine has not been punctured.

I have used this apparatus experimentally on the dead, and also in operating for obstruction on the living, and have found it work well. My first model (that illustrated) is in fact quite satisfactory, but I intend to have it reduced slightly in size, when it will be more convenient to handle. I am indebted to Messrs. Weiss and Co. for the care they took in its manufacture.

In conclusion, I wish to emphasize the following points: firstly, the rubber sheet (or dam) must be evenly stretched and firmly held by a strong rubber band; and secondly, the hole in the sheet must be quite small—half to three-quarters of an inch across.

An Intestinal Crushing Clamp. By W. ERNEST MILES, F.R.C.S., London.

The Crushing Clamp here illustrated (*Fig.* 354) is one which has been especially made for me by the Holborn Surgical Instrument Company for use during the radical abdomino-perineal operation for cancer of the rectum. The proximal half of the blade is nearly an inch in breadth, in order that the crushed part of the pelvic colon shall be sufficiently wide to permit of easy division between the ligatures. The distal portion of the blade is much narrower, as it is only necessary to crush the mesocolon, for hæmostatic purposes, along the line of division. The advantage of using this clamp is that it greatly minimizes the risk of infection when the pelvic colon is divided.

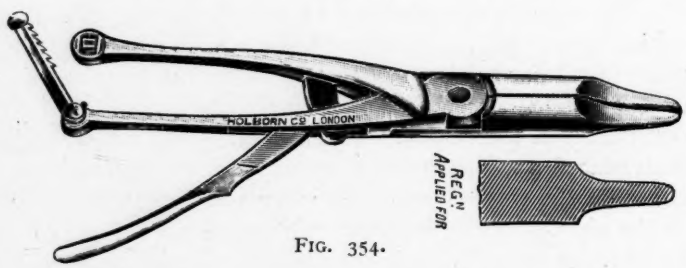


FIG. 354.

REVIEWS AND NOTICES OF BOOKS.

Manual of Operative Surgery. By JOHN FAIRBAIRN BINNIE, A.M., C.M. (Aberdeen). Surgeon to the General Hospital, Kansas City. 6th Edition, revised and enlarged. Pp. 1251, with 1438 illustrations, a number of which are in colours. 1913. London: H. K. Lewis. Price 30s. net.

THE first edition of this well-known work appeared as recently as 1904, and its success has set upon it a seal which makes the reviewer's work one of supererogation.

In a sense the book is an international product, the credit of which must be divided between Britain and America, for Dr. Binnie is a graduate of Aberdeen, though his present field of work is in the United States. Accordingly, the book combines the thoroughness, precision of statement, and caution, which are often regarded as Scotch characteristics, with the open mind and eager receptivity for new ideas which we are accustomed to associate with the New World.

The scope of the book, as laid down in the original preface of the first edition, has been in some respects enlarged, but it retains its main characteristics. It is not written for students, and does not include those classical procedures which are enshrined in the pages of text-books. It is intended as a survey of the growing edge of operative surgery. As the author states: "Great care has been taken to avoid the perspective of a text-book, where emphasis must be placed on the common rather than on the unusual. In this work the constant endeavour is to give aid and guidance to the surgeon when he is in trouble; hence, far more space is devoted to such rare and difficult operations as hypophysectomy, than to many operations of much greater everyday importance, but which ought to be familiar to every graduate."

Dr. Binnie has spread his net wide in surgical literature. Rejecting what is worthless, he has included not only established new procedures, but also those which are upon their trial. While he does not hesitate to express his own opinion, he assumes throughout that his readers possess the critical faculty, and he provides, in concise form, materials upon which they may form their own conclusions in respect to the vexed questions of operative surgery. In these days, when the flood of periodical literature renders the task of keeping "up-to-date" so difficult, this is a great service to have rendered to surgery. Dr. Binnie has the rare faculty of tearing the heart out of a complicated subject, or of a long and exhaustive paper, and presenting the result in a few concise sentences which are none the less so clear and complete that for a practised surgeon they supply all that is wanted. Whenever difficulty arises in conveying an idea clearly by means of words, the weak spot is strengthened by clear illustrations, either pictorial or diagrammatic. Dr. Binnie's method appears to be that of first assimilating an author's ideas, and then reproducing them in his own language. He thus avoids the intellectual haze, equally indefinable and impenetrable, which surrounds the machine-made *précis*. It would be unfair to convey the impression that the work is a mere critical compendium. It supplies plenty of evidence of its author's resource and originality as a surgeon, and is stamped throughout with his individuality.

The reader must not look for charm of style in this book, but he will find its language is as clear, direct, and businesslike as the orders of a foreman to his gang. Dr. Binnie has imitated the achievement of the physicists who liquefied air. He has given us the surgical atmosphere of to-day in a pint pot. Much as we may deplore the loss of literary charm which the author's methods involve, the technical literature of the future will have to conform more and more to the model presented by this book, of the unadorned shorthand of ideas

On Diseases of the Rectum and Anus: Including the sixth edition of the Jacksonian Prize Essay on Cancer. Fourth edition, reprinted to include the opening address on the Surgical Treatment of Rectal Cancer, at the Annual Meeting of the British Medical Association, at Liverpool, 1912. By HARRISON CRIPPS, F.R.C.S. Fourth edition. Pp. 588 + xxvii. Thirty-four illustrations. London: J. & A. Churchill. 10/6 net.

THIS is a reprint of the third edition of Mr. Cripps' well-known book, together with some additions to the tabular account of recent cases, and the text of his address on rectal cancer given at Liverpool in 1912. The summary of recent cases includes 65 patients seen between 1905 and 1911. In these, the radical operation was performed in 34 per cent, as compared with 22 per cent in the previous series. The survivals for three years or over were 45 per cent, as compared with 38 per cent.

The principal note of the Liverpool address is a protest against the suggestion of the extensive or total removal of the rectum in all cases. The author is quite unconvinced that the disease spreads to any extent along the apparently healthy bowel walls.

The book as a whole is chiefly remarkable for the little change that it has undergone since its first appearance. It clearly is an expression of the author's views and experiences, and not an exposition of rectal disease in the light of modern knowledge. As examples of this may be mentioned, that the trans-sacral route for cancer excision is dismissed in a few paragraphs, the abdominal route is not systematically described at all, and the only procedure mentioned for inguinal colotomy is that in which the muscles are all cut in the line of the skin incision, and the bowel sewn to the parietes by interrupted stitches. The statement (p. 516) that "I am not able to see the advantage of doing a preliminary colotomy before excision" is at variance with the opinion of most surgical authorities, and the reason for this, that "fæces appear quite innocuous in any wound if the part is kept clean," seems somewhat paradoxical.

(A portion of the above work is issued as a separate volume, entitled "Cancer of the Rectum," including 277 pp. and 11 illustrations. Price 5s. net).

Genito-urinary Diagnosis and Therapy. BY DR. ERNST PORTNER (Berlin). Translated and edited by BRANSFORD LEWIS, M.D., B.Sc. (St. Louis). Pp. 221, with 43 Illustrations. London: Henry Kimpton. Price 10s. 6d. net.

THIS is a translation of Dr. Portner's "Therapeutisches Taschenbuch der Harnkrankheiten," which is vol. viii of Fischer's "Therapeutische Taschenbucher." The original consists almost entirely of treatment, though a few remarks are made on points of importance in the diagnosis; in fact, the author in his preface expressly disclaims any pretention to the book being a manual of diagnosis.

Such a book, dealing so much with treatment and so little with diagnosis and pathology, can hardly be other than dogmatic and empirical; it consists largely of lists of prescriptions; often no indication is offered as to why one drug should be preferred to another, and we can only conjecture that we are to keep on trying till we find the right one.

The illustrations are pictures of various instruments and appliances.

We think the best chapters are those on local anæsthesia and the disinfection of the instruments used in urinary surgery, though we would like to know why Dr. Portner considers formalin vapour to be unsatisfactory for the sterilization of silk-web catheters.

We are doubtful if the book was worth the labour of translation. On the other hand, we are certain that, if the translator thought that it was, he should have taken the pains to translate it accurately and with some attempt to write clearly. We select the following sentence as an instance of the difficulties of the translator: "It is therefore that a tuberculous process of the bladder alone becomes the object of therapeutic attack under certain conditions only."

As editor, Dr. Bransford has added illustrations of some of his own instruments, and no less than six pictures of his method of performing circumcision; he has

annotated the original text very freely, and in a somewhat personal spirit. If we were Dr. Ernst Portner, we should rather bridle on reading some of the editor's comments; at times they appear to be almost a direct negative.

There is a good appendix at the end of the book, on serological diagnosis and specific treatment of gonococcic infections; this is by Dr. A. Sophian, of Kansas City.

International Clinics: A Quarterly Journal of Illustrated Clinical Lectures. London and Philadelphia: Lippincott. Price 35s. per year. 4 vols.

VOL. I, 1913, pp. 302, contains some articles of surgical interest. Reder, in an article on chronic appendicitis, attaches great importance to the palpation of a tender spot on the right side of the pelvis, as ascertained by rectal palpation. Abrams writes about the treatment of aortic aneurysm by concussion of the spine in a way which does not appeal to the mere surgeon. Pugh reports 10 cases of Pott's disease operated upon by Allen's method of grafting a piece of the patient's tibia into the spinous processes of the affected vertebræ. In two of the cases the grafts either gave way or extruded, but the author is enthusiastic in praise of the method, provided that a much longer period of external support is allowed than that advised by its inventor. He suggests eight months of external support by plaster jacket as being necessary. By far the most valuable part of the book is the last section of 120 pages by the Editor, Dr. Cattell, assisted by Dr. Lucius Johnson, on the progress of medicine during 1912.

Vol. II, pp. 312, contains very little of a new or original character in its surgical articles. Babcock writes on the treatment of carcinoma by emulsions prepared from the human fœtus, and reports 21 cases. He concludes that this treatment has no distinct value in malignant disease in man. Skillern gives a review of a year's fracture work at the University Clinic of Pennsylvania, dealing with 299 cases, from which we are surprised to learn how conservative are the methods there in vogue. All the other papers are on general subjects, other than surgical, and mostly represent recapitulation lectures.

Diseases of the Ear. By PHILIP D. KERRISON, M.D. with 331 illustrations in the text and 2 full pages in colour. London and Philadelphia: J. B. Lippincott Company. Price 18s. net.

IN the preface to his book, Dr. Kerrison gives as the justification for its appearance the great advance of knowledge in otology during the last ten years. Though the work contains much that is recent, we do not feel that the author has adequately represented the advance in all branches of the subject.

The arrangement of the chapters differs slightly from that usually adopted, chiefly in the separation of the anatomy, physiology, and pathology of the internal ear from that of the external and middle ear.

The first nine chapters deal with the anatomy of the external and middle ear, their suppurative and non-suppurative diseases, and are well arranged and very readable. Among them we would commend a chapter on the " Subjective Symptoms of Aural Disease," especially the section dealing with tinnitus.

We should like to suggest that the subject of hearing tests is scarcely up-to-date: there is no mention of the monochord as a means of determining the upper tone limit, the old-pattern Galton whistle is depicted, though the Edelmann-Galton is recommended as a better apparatus, and there is no word of the " voice-raising " test. Dr. Kerrison has invented a series of tuning-forks of a convenient pattern, but it is questionable whether this is an unmixed blessing, since in view of the already existing series the possibility of arriving at a standardization of tests is thus made less likely.

The diagnosis of otosclerosis is made to appear too simple, and we do not think that the majority of aurists will agree that the upper tone limit remains normal in that disease.

There then follow two excellent chapters on the labyrinth, for which we have nothing but praise, and every student will do well to read them carefully. The author has here brought all his care and experience to bear, and the result is an admirable example of clearness in description, without the needless complications and obscurities with which this subject is apt to become surrounded. Especially ingenious is the simple device for the graphic representation of the position of the semicircular canals constructed from two small cards.

The various operations of aural surgery are admirably illustrated and clearly described in separate chapters; particularly good seems the author's operation for opening the labyrinth. In this connection, the question of suppurative meningitis is discussed, and Dr. Kerrison takes a particularly pessimistic view of this complication of ear suppuration; in considering the treatment, the Haynes operation for opening the meninges in the middle line between the cerebellar lobes is well described; there is no mention of translabyrinthine drainage.

There then follow several short chapters on various subjects—facial paralysis: syphilis of the ear and salvarsan; vaccines and the His leucocyte extract, in which the author has considerable faith; and the teeth in relation to the ear.

The plan of the book is good, and the carrying out of it successful as far as it goes; but we feel that, in spite of its size, there is a great deal of recent work omitted, which should at least be given a place, even if the author does not feel sure of its ultimate value.

Surgery and Diseases of the Mouth and Jaws: a Practical Treatise. By VIBRAY PAPIN BLAIR. Pp. 638 and xxxvi. With 384 illustrations. 2nd Edition. London: Henry Kimpton. Price 24s. net.

THIS work deals with the diseases of the mouth and jaws in a detailed way and from the point of view of the specialist. The conditions treated of form a natural group, admirably compact and suitable for the subject of a monograph. The author, however, as he says for the benefit of his dental students, has devoted some fifty pages to elementary general surgical principles. These pages seem somewhat out of place among the special and advanced material of which the rest of the book consists.

This edition, published within a year of the first, contains but few alterations, and does not therefore call for extended notice. Special attention is given throughout to plastic surgery, and the description of the treatment of cleft palate is particularly full. More space might perhaps have been given to malignant disease of the jaws, of which the clinical description, especially with regard to the numerous difficulties of diagnosis, is rather summary. The description of operations on the jaws is at times somewhat formal, and the writer is inclined perhaps to over-emphasis in referring to the dangers of hæmorrhage. A long section is devoted to carcinoma of the tongue. On this subject the teaching of Butlin is followed fairly closely, and is illustrated by free quotations. An excellent feature of the book is the inclusion of trigeminal neuralgia within its scope. A very full description of the treatment by alcohol injection is given. For cases in which radical operation is necessary, section of the sensory root is recommended in preference to excision of the Gasserian ganglion.

Surgery of the Vascular System. By B. M. BERNHEIM, A.B., M.D. Pp. 104. 53 illustrations. London and Philadelphia: J. B. Lippincott Company. Price 12s. 6d. net.

IN the preface the author says: "This book is intended to be a practical and suggestive aid to the surgeons interested in this branch of work; in it the various methods employed in the field of vascular surgery will be explained as simply as possible, a fundamental knowledge of the condition in hand being always taken for granted." This is strictly true of the book.

The work is a booklet of 100 pages, very clearly written and most beautifully illustrated with 53 drawings by James F. Didusch. Succeeding a very lucid chapter

on "general technique," are chapters on "transfusion," "end-to-end suture," "lateral anastomosis," "arterio-venous anastomosis," "varicose veins," "surgery of the heart," and two chapters on "aneurysm."

As the author clearly states, the book is of use only to the surgeon who is interested in this kind of work, though it is surely of some importance that every operating surgeon should be familiar with the technique necessary to close an opening in a main vessel, or even to unite a main vessel torn across in the course of some massive trauma. Definite principles are fully laid down, and are those of Carrel, the greatest worker in vascular surgery.

The author's own operation for blood transfusion by means of a two-pieced tube is an excellent one, but for the admitted fact that clotting occurs in the tubes; his method of performing lateral anastomosis (introduced in collaboration with H. H. B. Stone) is as perfect as possible.

It is undoubtedly a book which should be mastered by every surgeon doing regular operative work, and is a fine addition to the literature of the subject.

Surgical Operations with Local Anæsthesia. By ARTHUR E. HERTZLER, M.D. Pp. 210. 104 illustrations. New York: Surgery Publishing Co. 1912. Price 12s. post paid.

THIS booklet of 200 pages gives by far the best account of the technique to be mastered in order to become proficient as an operator under local anæsthesia.

The first forty-six pages deal with the drugs used and the methods of administration. The author very properly lays stress on the endermic infiltration as being at once the most difficult and the most perfect of all forms.

We are not convinced that the syringe illustrated is the best instrument on the market to-day; the needles are not fine enough, and the syringe is not nearly strong enough.

There is no adequate account of the principles of "Anoci-association," as practised by Crile in America and Moynihan in this country. There is, however, a very excellent account of the "neural anatomy of the abdomen," and the methods of securing local anæsthesia therein.

The author discusses the effect of quinine on the tissues, based on his own experiments. He states that a solution of quinine causes an exudate, at first amorphous, which soon coagulates, forming a granular fibrin. This exudate begins in a few minutes, and is complete in twelve to twenty-four hours; it lies between the connective-tissue fibrils, and is not absorbed under one to two weeks. It is the granular fibrin which causes the anæsthesia by compressing the nerve fibres; but they themselves show no sign of injury. It is of great interest to note that quinine injections allowed to remain in situ for a few moments, result in only a small amount of fibrin formation, the anæsthesia is very short, and healing is not impaired. The result of more quinine left a long time in situ is a much longer anæsthesia (up to two weeks), and some delay in union, with the formation of a less satisfactory scar. It follows that where a cosmetic result is required it is better to use a 5 per cent solution of cocaine without adrenalin.

It is of some interest that Rogers, in 1908, suggested injection of quinine to relieve after-pain.

All operations are fully described, and the book is very well written. The illustrations are excellent, and the work as a whole must appeal to all surgeons who desire to perfect their knowledge in this most desirable method of operating.

Disturbances of the Visual Functions. By PROF. W. LOHMANN, translated by ANGUS MACNAB, F.R.C.S. 1913. London: John Bale, Sons & Danielsson, Ltd. Pp. 184, with 39 illustrations, some in colours. Price 15s. net.

THIS book covers a very wide and varied field, and is full of interesting observations, the result of the author's work at the University Eye Clinic, Munich. After an epitome of the physiology and psychology of vision, he discusses the effects of blind-

ness, and the education of vision both for form and colour. The chapter devoted to abnormalities of central and peripheral vision is one of the best. Various theories regarding congenital amblyopia are considered. The author's view is that the retinal cones are not so closely packed at the macula as usual, or else that the nerve connections are less isolated and more grouped than normal; i.e. that the conditions at the macula of the amblyopic eye resemble those found in the periphery of the retina.

Full information is given on disturbances of adaptation to light and of "light-sense." There are two chapters on defective colour-vision. We are surprised that no mention is made of the work of Edridge-Green on this subject. Ten pages are devoted to "colour-hearing" and other optical co-sensations. He says, "the ordinary man cannot grasp colour-hearing," but some of those gifted with *audition colorée* associate the vowel sounds with green, black, red, and so forth; whilst to others the notes of the flute are blue, the violin red, etc. Reference is made to practically all visual defects, but some of them (nystagmus for example) might have been dealt with more fully.

The book is admirably got up, has an excellent index, and abounds in references to the literature of the subject.

Owing to the exigencies of time and space, the article dealing with Contemporary German Surgery has had to be postponed until the next number.

—EDITORIAL SECRETARY.

JOHN ABERNETHY.

1764—1831.

BORN in London in 1764, the son of a London merchant, John Abernethy was the grandson of that John Abernethy who rent the Irish Presbyterian Church into the sections of Subscribers and Non-subscribers, by remaining as minister at Antrim when the Synod had ordered him to Dublin. Abernethy derived from this grandfather both his obstinacy and his love for the medical profession. John Abernethy was educated at Wolverhampton Grammar School until he was apprenticed at the age of fifteen to (Sir) Charles Blicke (1745–1815), who lived in Mildred Court, close to his father's house in Coleman Street. Blicke was surgeon to St. Bartholomew's Hospital, and Abernethy as his apprentice attended the surgical lectures of Percivall Pott (1714–1788); but he learnt his anatomy at the London Hospital, where he was prosector to (Sir) William Blizard (1743–1835). John Hunter taught him pathology, and showed him how morbid and comparative anatomy might help to advance surgery.

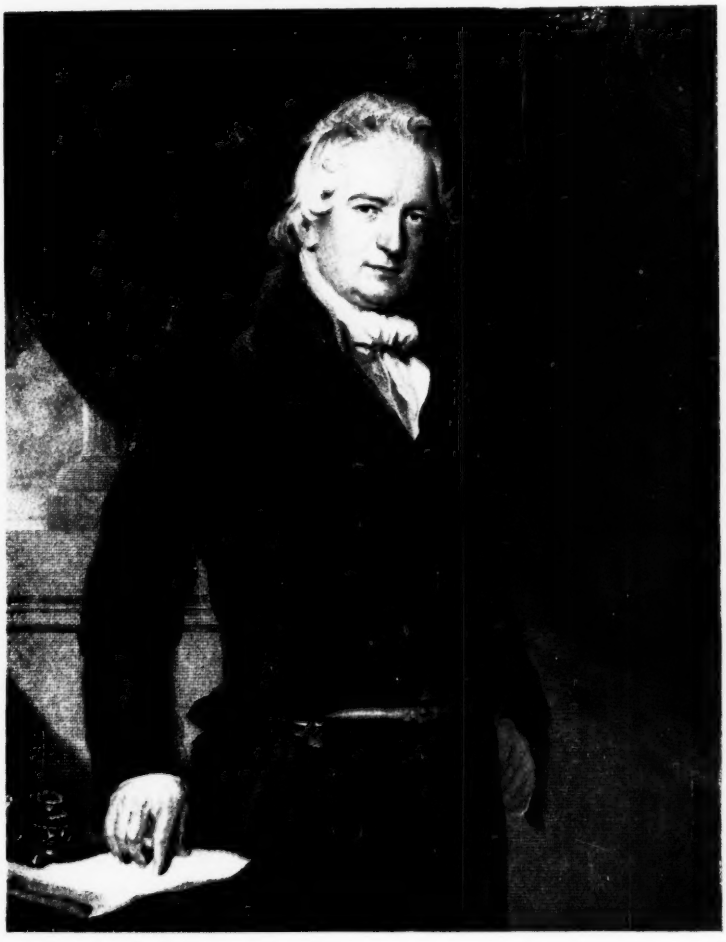
Abernethy was elected assistant-surgeon to St. Bartholomew's Hospital in 1787, when Pott resigned the office of surgeon; but it was not until 1815 that he became full surgeon. By this time all surgical originality had been crushed out of him. The work of his life was nearly done, and he had never had charge of wards except as the deputy of his surgeon.

His energy and work were seen in other fields. He became the founder of the great medical school attached to St. Bartholomew's Hospital, proved himself a lecturer of the highest order, and was the foremost exponent of the views of John Hunter. It was mainly through him that the Hunterian tradition in surgery reached the present generation through the genius of Lawrence, of Green, and of Savory.

Abernethy made his name as a teacher when he lectured on anatomy at his house in Bartholomew Close; and after his election to the Staff of St. Bartholomew's Hospital, his pupils followed in such numbers that the Governors of the hospital found it necessary to build a special theatre as early as 1791. The secret of Abernethy's success as a teacher lay in his ability to interest the audience, and to send them away with a good conceit of themselves. Sir Benjamin Brodie says, "He kept our attention so that it never flagged, and what he told us could never be forgotten. He did not tell us so much as some other lecturers, but what he did he told us well. His lectures were full of original thought, of luminous and almost poetical illustrations, the tedious details of descriptive anatomy being occasionally relieved by appropriate and amusing anecdotes. Like most of his pupils, I was led to look up to him as a being of a superior order, and I could conceive nothing better than to follow in his footsteps." His position at St. Bartholomew's Hospital opened to him the highest posts at the College of Surgeons of England, and he became President in 1826. He married Miss Anne Threlfell in 1800, and by her he had two daughters. He died at Enfield, after a lingering illness, on April 20, 1831.

Abernethy was an early example of a surgeon who based his practice more on physiology and pathology than upon the results of operation, though he extended John Hunter's method of distal ligature for the cure of aneurysm by tying the external iliac instead of the femoral artery. As a scientific surgeon he followed John Hunter, but had neither the originality nor the industry of his master. Yet he loomed larger in the eyes of his contemporaries than did Hunter: to his pupils, because of his gifts as a lecturer; to his colleagues, because of his blameless life, his sterling honesty, and his great independence of character; to the general public, for his bluntness of speech and eccentricity of manner, which made him a topic of conversation and allowed of endless stories being told about him.

A busy man, he hated loquacity, and forgave the fee when a patient came holding up his forefinger. "Burn?" said Abernethy. "No, bite," said the patient. "Dog?" asked Abernethy. "Parrot," replied the patient; and the interview ended with a few simple directions for treatment.



JOHN ABERNETHY

Reproduced from a Painting by Sir Thomas Lawrence.

CONGENITAL ELEVATION OF THE SCAPULA: A SERIES OF 18 CASES, WITH A DETAILED DESCRIPTION OF A DISSECTED SPECIMEN.

By H. A. T. FAIRBANK, London.

Cases of congenital elevation of the scapula occur with sufficient frequency to make it advisable that this deformity should be kept constantly in mind. It is a matter of some importance to decide whether a child with an elevated shoulder-blade and lateral curvature of the spine is suffering from a congenital or an acquired condition. The prognosis of the two conditions is very different, and often the treatment is dissimilar. Cases falling under the above heading can be arranged into various classes, according to the degree in which the condition differs from the normal, and also according to the presence or absence of other malformations of the skeleton. Apart from the abnormally high position which the scapula occupies, the other conditions frequently met with in association with it are congenital scoliosis (in some cases resulting from the presence of a wedge-shaped half-vertebra), suppression of vertebræ, fusion of ribs, and the occurrence of a cervical rib. Any or all of these latter deformities may occur apart from elevation of the scapula; but the fact that they are so often met with in conjunction with this abnormal condition of the shoulder makes us look for a common cause. Various explanations have been suggested, viz., malposition of the fœtus in utero which prevents descent of the arm (which is said to be really a cervical appendage), deficient liquor amnii, injury during birth, and the influences of atavism. Though these might explain the abnormal position of the scapula in certain cases, none of them can explain the gross abnormalities of vertebræ and ribs, nor the development of a new portion of bone anchoring the scapula to the spine. The only explanation which seems to me to account for all the deformities is that the conditions were the result of faulty segmentation of the mesoblast in early fœtal life. Even this theory does not help us much, for we have no idea what causes this irregular segmentation. Supposing we attribute it to a primary error in the primitive nervous system, a suggestion which I believe has been made without much foundation, we are still in ignorance of the real causation, and we can do nothing to prevent its occurrence. Since Walsham and Willet[1] in 1880 published the first detailed description of a specimen which they had dissected, most of the information contained in literature is derived from clinical sources. No excuse is therefore necessary for recording this instance of the deformity which I had the opportunity of dissecting.

SPECIMEN OF CONGENITAL BILATERAL ELEVATION OF THE SCAPULA.

V. C., female, aged 6 weeks. Died at the Hospital for Sick Children, Great Ormond Street, of marasmus. The specimen shows both scapulæ to lie at an abnormally high level, and to be fixed in an abnormal manner to the vertebral

column. On the right side, the scapula is held to the spine by a cartilaginous bridge. On the left side, the fixation of the scapula is produced by a band of fibrous tissue. In addition, there is gross mal-development of the vertebral column and ribs. The right forearm is included in the specimen, as the radius is absent on this side. The child also had a cleft palate. Below is a detailed description of the muscles, bones, etc., as they were revealed by dissection.

The Muscles.—

Trapezius.—This was deficient to a large extent on both sides. Below the level of the spines of the scapulæ, both were non-existent. Above, the muscles

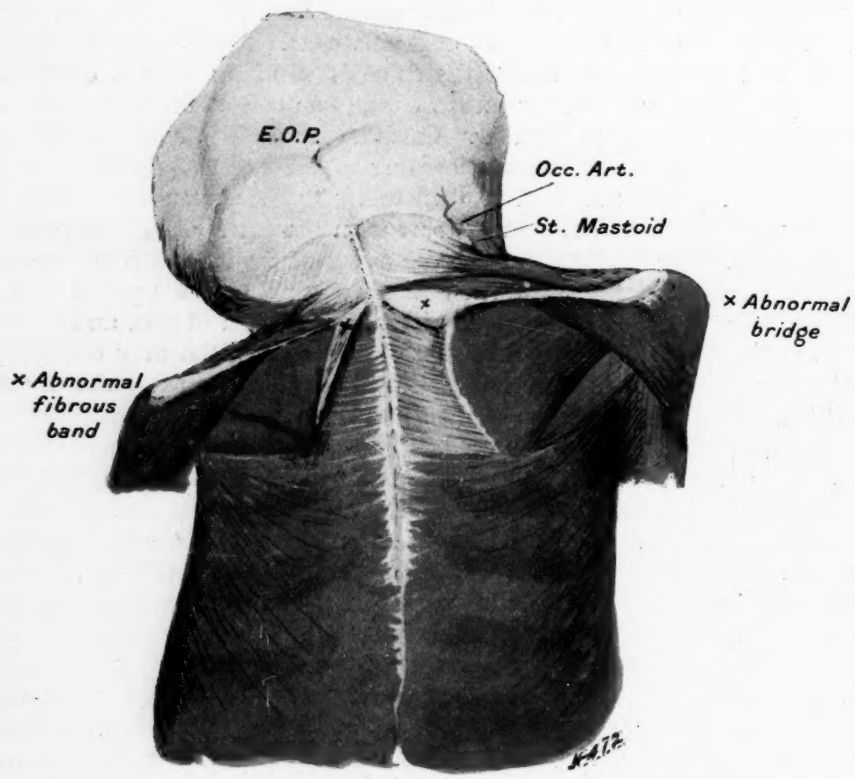


FIG. 355.—Dorsal aspect of specimen after removal of skin and fascia, showing irregularities of the first layer of muscles.

were represented by an aponeurosis attached to the *inferior* curved line of the occipital. From this aponeurosis muscle fibres arose and passed to the clavicle, acromion, and outer part of the scapular spine. On the right side, other fibres arose from the upper margin of the bridge of cartilage, and passed horizontally outwards to the inner part of the scapular spine. On the left side, these fibres arose from the fibrous band and scapular spine, and passed out to the scapular spine (*Fig.* 355).

The *latissimus dorsi* was well developed on both sides.

Rhomboids.—On the right side, these muscles were represented by an aponeurosis extending from the upper dorsal spines to the vertebral border of the scapula, from the bridge of cartilage above to the angle of the scapula below. On the left side, they were represented by a thin sheet of muscle directly continuous with the latissimus dorsi below, and passing to the scapula deep to the fibrous bridge holding this bone to the spine.

Splenius Capitis.—This muscle on both sides was attached to the skull beneath the sterno-mastoid, and ended below in the bridge of cartilage and the projection from the vertebral border of left scapula respectively.

FIG. 356.—Dorsal aspect of specimen, showing deeper muscles.

Trachelo-mastoids.—These, similarly, could only be traced below to the abnormal bridge and cartilaginous projection (*Fig.* 356).

Levator Anguli Scapulæ.—Normal on both sides.

On each side was found a muscle which should, apparently, be labelled *occipito-scapularis.* Above, it was attached to the skull just beneath the trapezius aponeurosis above mentioned, from the mid-line outwards for an inch or more. Below, it was attached on the right side to the bridge of cartilage, on the left to the projection of the vertebral border of the scapula (described below).

The various portions of the *erector spinæ* were not differentiated, but it was noticed that the superficial fibres were interrupted by the bridge of cartilage, while the deep fibres passed on beneath it. On the left side some of the superficial fibres were blended with the deep aspect of the fibrous band. The shortness of the neck made it impossible to determine the exact attachment of the recti and other deep muscles. The other muscles attached to the scapula appeared to be normal, except in so far as alteration in their shape and the direction of their fibres was produced by the differences in shape and position of these bones.

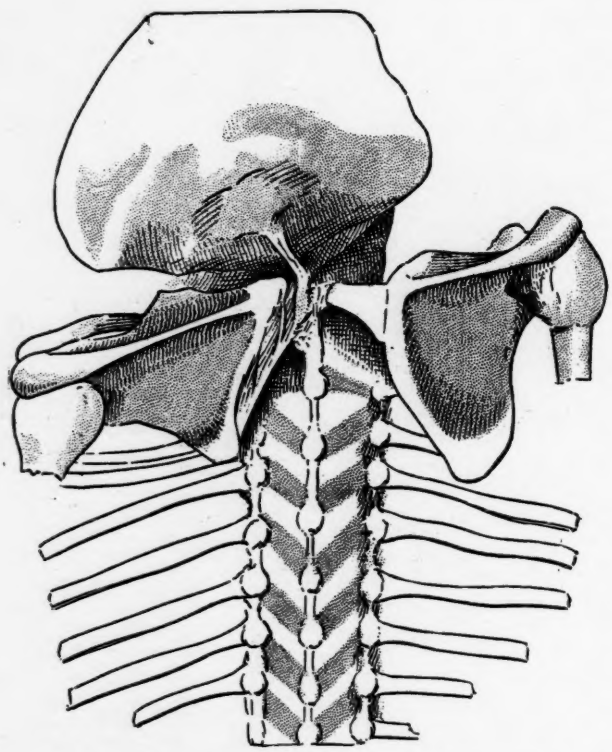


FIG. 357.—Dorsal aspect of specimen after removal of all muscles.

The Bones.—

Right Scapula and Bridge.—The right scapula is fairly normal in shape, and shows a good broad band of cartilage along its vertebral border and at the inferior angle (*Fig.* 357).

The bridge consists of unossified cartilage, triangular in form, with its base at the vertebral border and the apex at the spine. It measures 1·5 cm. from base to apex and 1·1 cm. at its base. Its base is fixed to the cartilaginous vertebral border of the scapula by a hinge of fibrous tissue. Its apex articulates with the lamina of a lower cervical vertebra. It is impossible to determine the exact vertebra without destroying the specimen. This articulation is brought about mostly by fibrous tissue, but a small joint cavity is present. There is, therefore, some movement possible between the bridge of cartilage and the spine on the one hand, and the bridge and the scapula on the other.

The Left Scapula and its Attachments.—The left scapula is placed nearer to the mid-line and at rather a higher level than the right. The inclination of the head and neck to the left brings the left shoulder in close proximity to the skull. The shape of the left scapula is markedly abnormal. Its vertical measurement is greatly diminished. The vertebral border above the spine slopes markedly outwards to the superior angle, while below the spine it passes downwards and outwards for a short distance, and then nearly vertically downwards. The sloping of the two portions of this border is accentuated by the presence of a cartilaginous projection from the border, opposite the attachment of the spine

to the scapula. This projection is conical, with a rounded apex, and is directed inwards and slightly upwards towards the spinous processes of the lower cervical vertebræ, to which it is attached a trifle higher than the bridge on the right by ligamentous tissue rather less than a quarter of an inch in length. These fibres form the highest part of a thick fibrous band, which is more or less triangular in outline. Its apex is attached to the lower cervical and upper dorsal spinous processes, while its base extends along the vertebral border of the scapula from the cartilaginous projection above mentioned down to the angle. This fibrous band takes the place of the triangular cartilage of the other side, though it has a much more extensive attachment to the scapula. The spines of the lower cervical and upper three or four dorsal vertebræ appear to be fused, and the lower cervical and 1st dorsal are somewhat deviated to the left. The *ligamentum nachæ* seems to be continuous with some of the fibres of the ligamentous band passing to the left scapula. The rhomboids, be it remembered, passed beneath this ligamentous band.

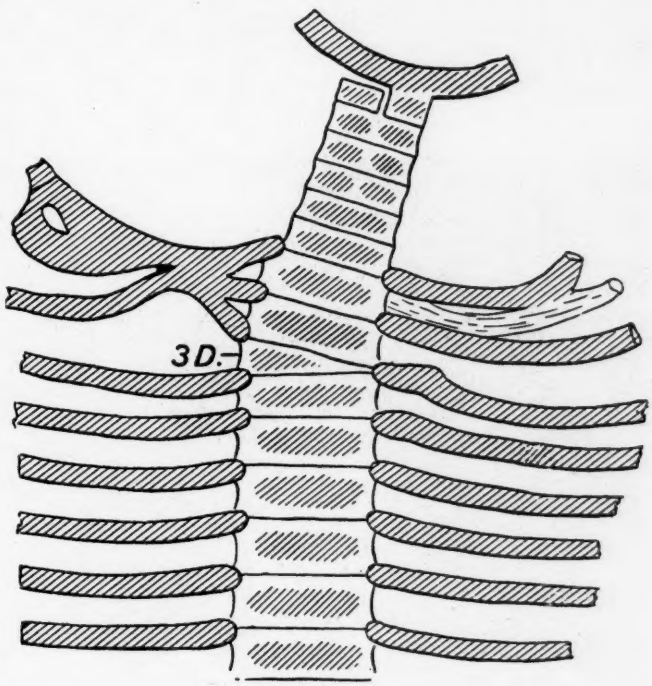


FIG. 358.—Diagrammatic representation (anterior aspect) of portion of occipital bone, all the cervical vertebræ, and most of the dorsal vertebræ and ribs. Note half-vertebra, fusion of ribs, etc.

The Spine. — The spine displays a marked curve in the cervical and upper dorsal regions, this portion of the spine being tilted to the left owing to the 3rd dorsal vertebra being wedge-shaped, the right half only being present. Below this point the dorsal spine is straight (*Figs.* 358 and 359).

Cervical Vertebræ.—Only five of the series can be definitely made out, and in three (possibly four) of these the body is ossifying from two separate centres. Above, the condition seems to be this: the anterior arch of the atlas is divided into two. The left half of the vertebra is fused to the occipital bone, whereas the right half is free. If this interpretation be correct, there are six cervical vertebræ. The lowest displays a distinct attempt at the formation of a cervical rib on the left side, the length of this being nearly half an inch. On the right side, the transverse process is somewhat large and is closely connected with the first rib. Both these cervical ribs can be moved on the vertebra, but it is impossible to say whether this mobility is artificial or not. The neural arches of these vertebræ were not

completely dissected, but, as already stated, the lower spinous processes were fused and slightly deflected to the left.

Dorsal Vertebræ. — There are portions of eleven dorsal vertebræ in the specimen, and there is no reason to doubt that the twelfth was present, but it was not preserved. The third is only represented by a wedge-shaped body situated well to the right of the mid-line and, so to speak, squeezed from its proper position. The left half of this vertebra is absent. The rest of the dorsal vertebræ are normal. The laminæ of the first three and a half vertebræ are interesting. On the right side there are four laminæ, the first two being very shallow and fused, while the third is joined to the second by cartilage. On the left side the first is fairly normal; the second is very narrow and fused to the first, and the third is very broad and is probably formed by a fusion of three and four. The left transverse process of the second is minute. The third left transverse process is large, and has the third and fourth ribs articulating with it. The partial suppression of the left lamina and transverse process of the second vertebra confirms the opinion that the cartilaginous bar second in the series of ribs should be regarded as the second true rib.

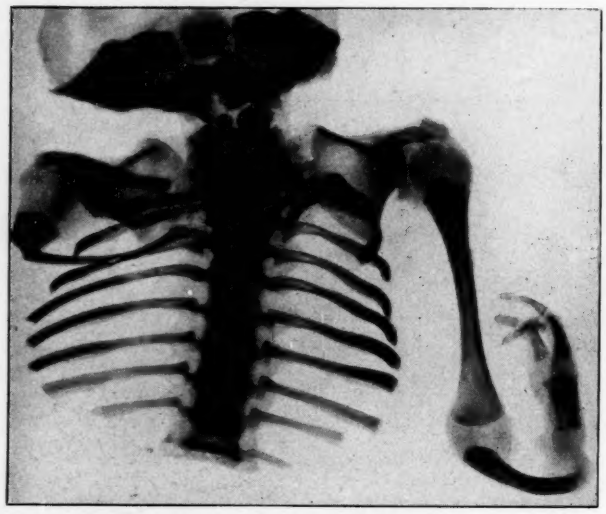


FIG. 359.—Radiogram of specimen, showing two centres of ossification of the centra of some of the cervical vertebræ, absence of the right radius, etc.

Right Ribs. — On the right side there are portions of eleven ribs. The upper three are attached to the first two and a half vertebræ respectively, and are partially fused, as seen in the sketch. The portion forming the head and neck of each is separate. The first and second are otherwise fused in their whole length, except for a foramen near the anterior end. The third fuses with the other two for a short distance, and then runs as a separate normal rib. The other ribs in the specimen are normal, as far as can be made out. None of them have been removed entire.

Left Ribs.—On the left side there are ten ossified ribs in the specimen, and in addition a fibro-cartilaginous bar lies second in the series. The first has a prominent head and a very broad extremity, the outer margin of which is fused with the cartilaginous second rib for three-quarters of an inch. The second rib is represented by fibrous tissue near the spine; it then becomes cartilaginous, and is fused for a short distance with the first rib as described above; beyond this fusion it is cartilaginous for a quarter of an inch, and then becomes fibrous again. Unfortunately the connection of this rib with the spine was partly destroyed in removing the soft parts, so that its exact connection cannot be

determined; but its fusion with the outer border of the first rib places its position in the series beyond doubt. The next rib articulates with the bodies of the first and second dorsal vertebræ, and would therefore be labelled the second thoracic rib, were it not for the presence of the cartilaginous rib described above, which lies between it and the undoubted first thoracic rib. The third left ossified rib, regarded as the fourth true rib, articulates with the bodies of the second and fourth vertebræ. Between this and the last rib described, there is no sign of any other rib. But for the presence of the cartilaginous second rib the numbering of the ribs would have been easy enough, allowing for the suppression of the third one on the left, corresponding to the missing half vertebra. A careful examination of the specimen shows, therefore, that while it is the left half of the third dorsal vertebra which is entirely suppressed, it is the second rib which is imperfectly developed. The other ribs seem to have normal attachments to the spine.

Other Points of Interest in the Specimen.—

The Head.—The head is tilted well over to the left, being much nearer to the left shoulder than the right, i.e., there is torticollis.

The Shoulder-joints.—These are apparently normal.

The Right Radius is entirely absent, the hand being bent towards the radial side at a right angle with the forearm.

The Thumb and its metacarpal bone are absent. The carpal bones were not investigated, though the radiogram rather suggests that the scaphoid and trapezium are present. (This specimen is now in the Museum of the Royal College of Surgeons, London.)

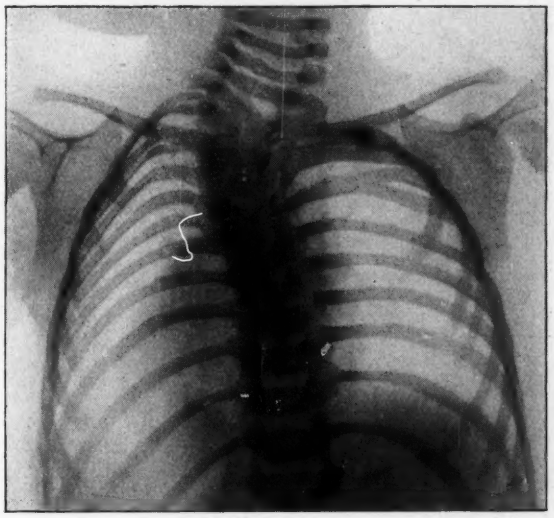


FIG. 360.—Boy, age 2. Congenital scoliosis. (?) Half-vertebra, partial fusion of ribs, scapulæ level and not elevated.

This case is, therefore, one of extreme departure from the normal, but, as is well known, there are many cases which, though included under the title of this paper, are very much less complicated.

Besides the case recorded above, I have notes of seventeen others, among which are instances of each variety of the deformity. To indicate the practical importance of diagnosing these cases, and of deciding to which class they belong, we may now pass in review this series, commencing with the least deformed and ending with the class of which the case above is a good example.

As already stated, the presence of a curvature of the spine not uncommonly leads to the true nature of the case being overlooked. Everyone is familiar with cases of scoliosis in which one shoulder is raised above the level of the other, usually on the side of the dorsal convexity. Very much less familiar are the cases of congenital scoliosis with the shoulders level. *Fig.* 360 is a radiogram of

such a case. It represents the condition of a boy, aged 2½, sent to me by Dr. Panckridge, of Petersfield. It will be seen that there is a short, abrupt cervico-dorsal curve to the left, with considerable indefiniteness of the upper dorsal vertebræ, and the possible presence of a half vertebra on the left side, representing the third dorsal segment. On the left side there are thirteen ribs, the highest being a cervical rib ; on the right side, the upper ribs showed gross irregularity, but it appears that the 1st and 2nd, 3rd and 4th, and 5th and 6th, respectively, are partially fused. In this boy the scapulæ were level. There was some rotation to the left, with slight prominence of the 2nd, 3rd, and 4th ribs behind. The 3rd, and to a less extent the 4th, right ribs projected in front, a condition made more obvious by a marked depression of the anterior end of the 2nd rib and its cartilage. This irregularity of the ribs in front, which, by the way, was the deformity for which he was sent to me, coupled with the abruptness of the spinal curve, at once suggested the advisability of having a radiogram taken to decide the exact condition present. Two other features which often serve to distinguish congenital from acquired scoliosis, namely, rigidity of the curved portion of the spine and flattening below the curve, were both absent in this case.

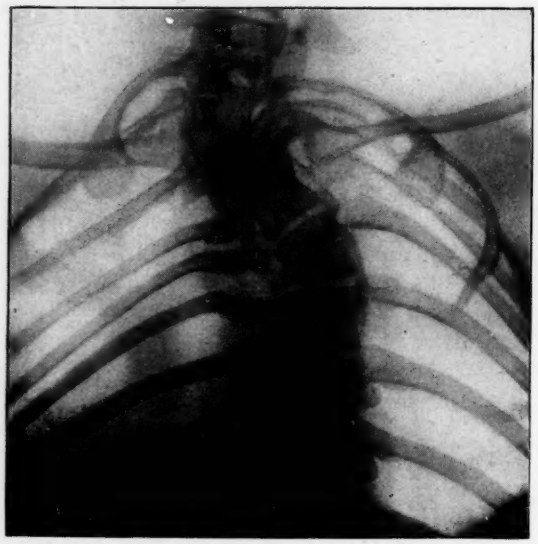
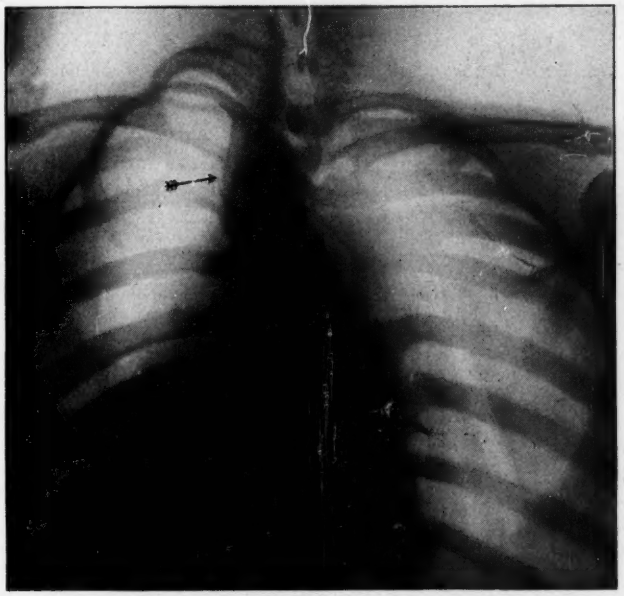


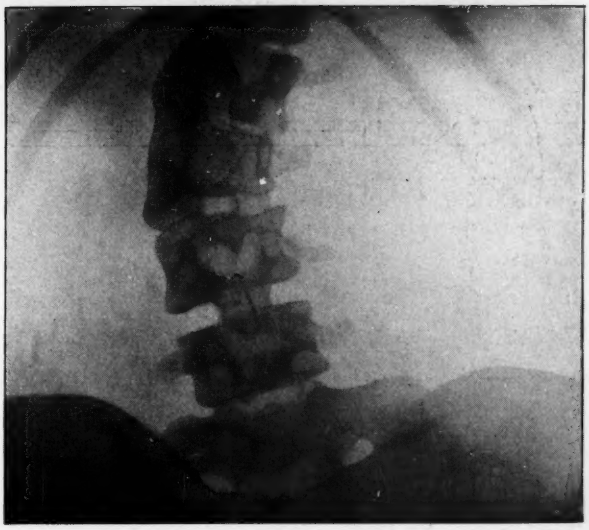
FIG. 361.—Female, age 21. Congenital scoliosis with secondary curves, and acquired elevation of left scapula.

Fig. 361 is that of a young lady, aged 21, sent to me by Dr. Salmon, of Bodmin, for spinal curvature. The suggestion had been made that it might be a case of so-called Sprengel's shoulder. On examination, the last two cervical and first dorsal spinous processes were found to be very prominent, while the sixth dorsal also stood out ; the spine between these two points was flattened, almost excavated, and very rigid. There was a right-dorsal left-lumbar scoliosis, with a fair amount of rotation to the right in the dorsal region, and only slight rotation to the left in the lumbar. The left breast was more prominent than the right, but the highest ribs in front on the right projected more than those on the left. The right scapula was elevated and markedly " winged," but was of normal size and shape, and its mobility was unimpaired. The radiogram shows a very abrupt curve, convex to the left in the upper dorsal region, with loss of definition of the vertebral segments suggesting the possibility of fusion of vertebræ in this region. The upper ribs on both sides are irregular. I believe the correct interpretation of the case to be that there was originally a congenital curve in the cervico-dorsal region, that an ordinary right-dorsal left-lumbar scoliosis developed secondarily, and that the elevation of the right shoulder resulted from the acquired rotation backwards of the right ribs. This was suggested by the history, and was supported

by the fact that the scapulæ were rapidly brought to the same level by a course of remedial exercises.

We now pass to the cases of true congenital elevation of the scapula. I prefer this name to the common one of Sprengel's shoulder, because Sprengel[2] was not the first to describe the condition, which was recognized by Eulenberg some twenty-eight years previously, while Willet and Walsham's case was published eleven years before Sprengel's article appeared. As a rule, the scapula in these cases is shorter from above down, and generally misshapen, lies nearer to the spine than its fellow, and is considerably restricted as to its movements, in addition to occupying an elevated position. Even in the cases without fixation of the scapula to the spine by an abnormal bridge, it is the imperfect mobility of the scapula which forms such a distinctive feature (*Figs.* 369, 373). On raising the arm, the elevated scapula does not move outwards like the one on the other side, and its lower angle does not rotate as it should as the arm is raised above the horizontal. Complaint is usually made by the parents of the asymmetry of the shoulders, and not on account of any disability of the arm, though occasionally weakness or disinclination to use the limb is mentioned. All movements of the arm are possible, except complete elevation to the vertical position. Only one case has been met with in which, though the elevation of the shoulder really





FIGS. 362 and 362*a*.—Congenital scoliosis with elevated scapula, normal in shape and mobility. Girl, age 17. Curve in upper dorsal region and another in lumbar region. 3 D vertebra wedge-shaped. 2 L abnormal. Partial fusion of ribs.

seemed to be congenital, yet the scapula was well formed and normally mobile. A girl of 17, a patient of Dr. Renton, of Dartford, displayed an abrupt curve with rotation in the upper dorsal region to the left, and another sharp curve with rotation, also to the left, in the lumbar region. Between these two curves there was only a slight curve to the right, the feature of the middle and lower dorsal region being an abnormal flatness. The left scapula was distinctly elevated, but it was not in any way fixed. The projection of the left ribs behind was above the centre of the scapula, and would not by themselves cause elevation of that bone. It is open to question whether this case should be classed with the others, in all of which the scapula was restricted in its movements; but since there is nothing to indicate how the scapula could have acquired this abnormal position, it is, I think, fair to assume that its displacement is congenital. The condition of the vertebræ and ribs in this case is seen in *Figs.* 362 and 362*a*. The abrupt high dorsal curve would seem to be due to the third dorsal vertebra being wedge-shaped, its right half, together with the corresponding third right rib, having been entirely suppressed. The lumbar curve is not so obviously congenital, but it is peculiarly abrupt for an acquired curve, considering the slightness of the curve to the right in the dorsal region, while the shape of the second lumbar vertebra suggests congenital abnormality. It will also be noticed that, in addition to the absence of one rib on the right—the third, it is believed—the fifth and sixth right ribs are partly fused, as are also the third and fourth left.

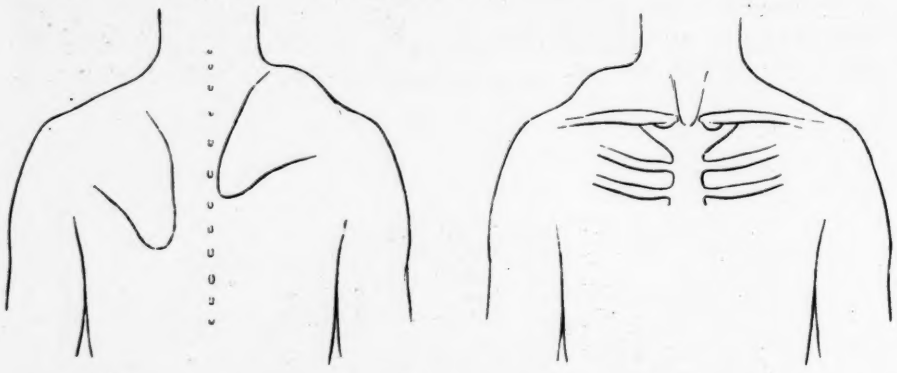


FIG. 363.—Woman, age 23. Congenital elevation of right scapula without abnormality of vertebræ or ribs.

We next pass to cases showing an almost normal, though elevated, scapula, very deficient in mobility, but not anchored to the spine by any abnormal osseous or fibrous band.* Some of these cases present no curvature of the spine, and no abnormality of vertebræ and ribs, while others are complicated by scoliosis and

* It is this class which may be closely imitated by a case in which one scapula has become elevated as the result of poliomyelitis affecting the lower fibres of the trapezius and serratus magnus. It is well recognized that deficiency of muscles, particularly of the trapezius, frequently accompanies congenital elevation of the scapula. The fixation of the shoulder-blade, the history, the absence of paralysis elsewhere, and frequently the radiographic appearances, will enable the congenital deformity to be distinguished from the acquired.

an amount of irregularity of the upper ribs quite unexpected after an ordinary physical examination. *Figs.* 363 and 364 were taken from an example of

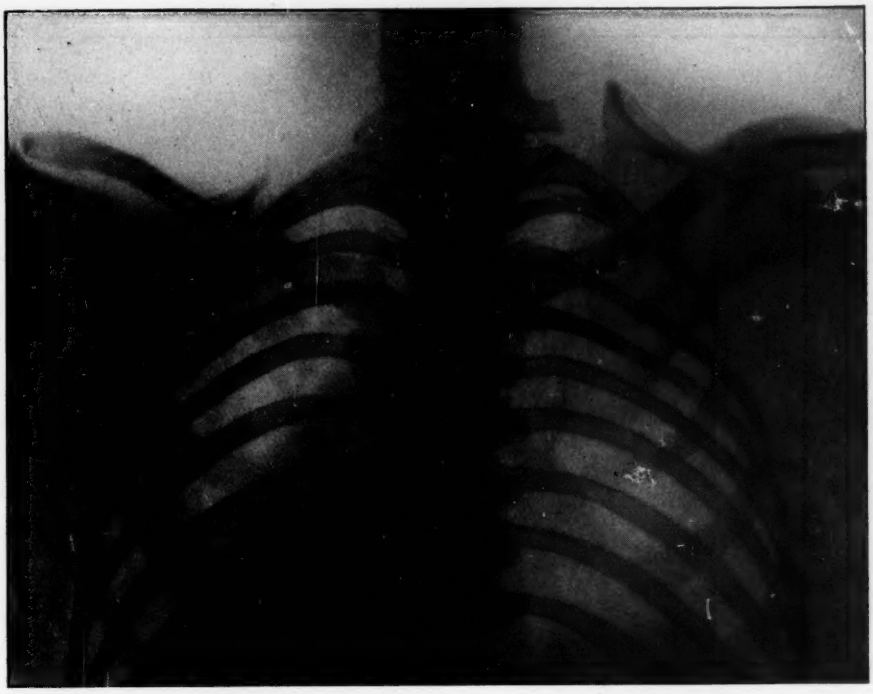


FIG. 364.—Case shown in Fig. 363. Note absence of deformity of spine and ribs. The transverse processes of the 7th cervical vertebra are large, that on the left being worthy of the title "cervical rib."

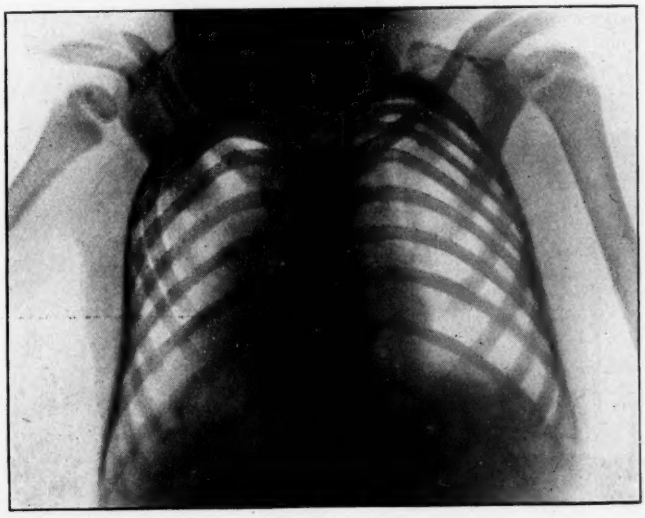


FIG. 365.—Girl, age 3, with bilateral elevation of scapulæ. The shortness of neck suggested suppression of cervical vertebræ, but this point could not be decided.

the first of these two groups The rough sketches make it clear how marked was the deformity, while the radiogram shows the absence of any changes in the bony skeleton. The right scapula was only slightly shortened in its vertical measurement, but its upper margin formed a pronounced prominence in the neck. It has been stated that in many cases the upper part of the scapular blade above the level of the spine is bent forwards, while in some cases the projection of the upper margin in the neck has been mistaken for a cervical rib. *Case* 15 is an example of bi-lateral elevation without gross vertebral mal-development, though the neck was

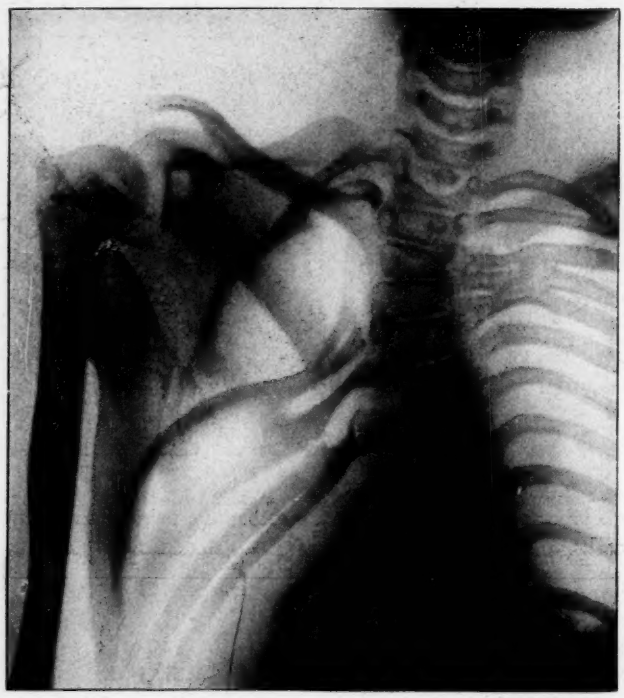


FIG. 366.—*Case* 3. Girl, age 12. Congenital elevation of left scapula, no bridge, congenital scoliosis and gross mal-development of ribs.

so short that suppression of cervical vertebræ was probably present, while the difficulties of taking a radiogram made it impossible absolutely to exclude rib deformity (*Fig.* 365). *Fig.* 366, taken from an example of the next group, shows elevation of an only slightly shortened, but definitely fixed, scapula, associated with very gross mal-development of ribs and congenital scoliosis, convex toward the affected shoulder. *Cases* 4 and 18 are also examples of this class. *Figs.* 367, 368, 369, show the appearances seen in *Case* 3, with the arms in various positions.

Next in order, we find a congenitally elevated scapula with an exostosis projecting mesially from its vertebral border. There are two examples (*Cases* 6 and 9) in this series.

Fig. 370 is a rough sketch of the right scapula of *Case* 6. Projecting from the vertebral border of the bone, about midway between the spinous process and the inferior angle, is seen a hook-like exostosis. This process could be bent slightly on the rest of the bone, suggesting either that it consisted of unossified cartilage, or that it was joined to the body of the scapula by a hinge of

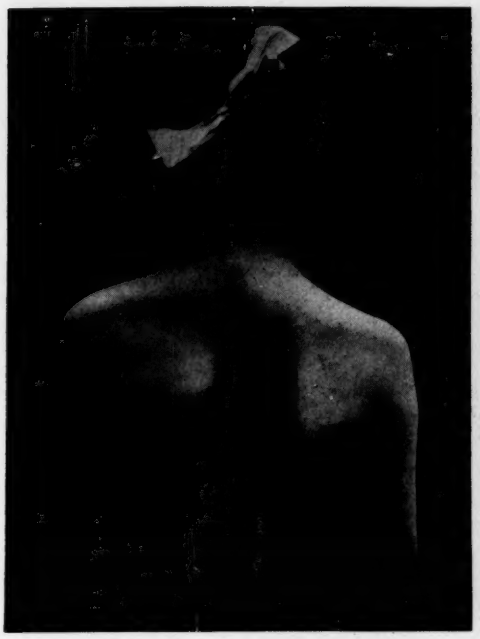


FIG. 367.—*Case* 3. Elevation of left shoulder. Radiogram seen in Fig. 366.

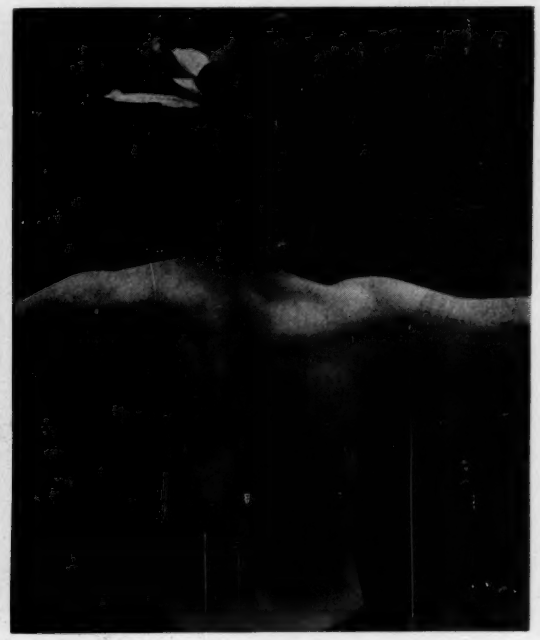


FIG. 368.—*Case* 3. With arms abducted.

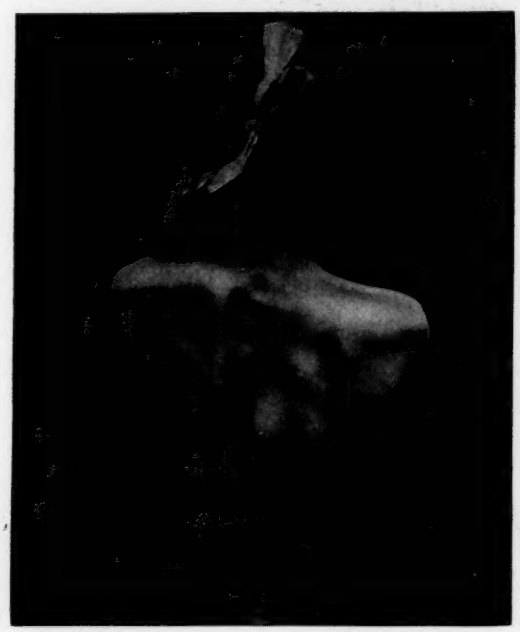


FIG. 369.—*Case* 3. With arms held horizontally forward; note fixity of scapula.

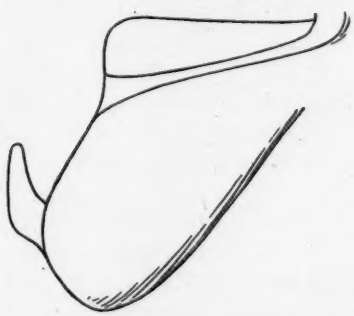


FIG. 370.—Diagram of right scapula with exostosis (*Case* 6).

fibrous tissue. The skiagram (*Fig.* 371) shows both scapulæ lying rather high, the right being the more elevated of the two, and in addition, it shows malformation of the upper dorsal spine, and suppression and fusion of ribs. Only eleven ribs can be made out on either side. On the right, the first rib is very slender, while the second and third, and the fourth and fifth, respectively, are partially fused. The head of the third is apparently absent.

Corresponding with this, the right half of the third dorsal vertebra also appears to be unformed, the left half being clearly distinguished. One and a half vertebræ have, therefore, been suppressed. If the skiagraphic appearances are read correctly, it is curious that no curvature of the spinal column is present.

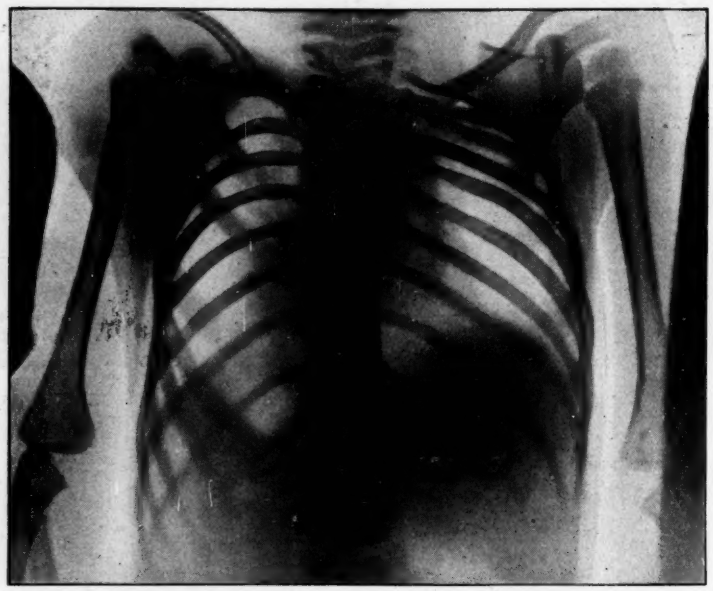


FIG. 371.—*Case* 6, from which Fig. 370 was drawn. Half-vertebra, fusion of ribs, etc.

In the other case of this kind (*Case* 9), the elevation of the left scapula was slight, but its position near the spinal column, its imperfect mobility, and its abnormal shape, justified the inclusion of the case in this series. Some mid-dorsal scoliosis was present, convex to the right. The left arm could not be raised to the vertical position. Projecting upwards and inwards from the vertebral border of the left scapula, just below the level of the spine, was a pointed process. This process was not unlike that in *Case* 6, but was attached at a somewhat higher level to the scapula, and was firmly welded to the rest of the bone. Its tip, which curled slightly upwards, yielded on pressure, and probably consisted of cartilage. There was no associated mal-development of ribs or vertebræ.

Reference may here be made to a case of exostosis of the sixth and seventh cervical spinous processes, shown by Mr. Maynard Heath[3] in the Children's Section of the Royal Society of Medicine. The exostosis projected downwards and outwards in the direction of the scapula, which occupied a normal position. This case is interesting in view of the fact that the abnormal

bridge of bone uniting some elevated scapulæ to the spine is regarded by a few as being of spinal and not scapular origin (J. Hutchinson,[4] Wilson and Rugh[5]).

Lastly, we place the cases in which the scapula is anchored to the spinal column by an abnormal bridge consisting of fibrous tissue, cartilage, or bone. Besides the dissected specimen, described in detail above, there are six other cases in which an abnormal bridge of bone existed, and in one of these the abnormal bone was present on both sides (*Cases* 2, 5, 8, 10, 14, and 17). In all of these some slight amount of movement was allowed to the scapula, a sort of hinge being present between the bridge and the scapula on the one hand, or the bridge and the

FIG. 372.—*Case* 8. Boy, age 7. Left scapula elevated and anchored to spine by bridge of bone, which is easily seen in the illustration.

FIG. 373.—*Case* 8. The same boy, showing limitation of movement of arm typical of these cases.

spine on the other. If fusion had taken place at either end, the inner, i.e., the junction of bridge and spine, was the more likely site. In two cases, the bridge of bone was joined to the scapula by a hinge of elastic or fibrous tissue; in two by cartilage; in the rest, the exact bond of union was not ascertained. To the spine, the bridge was united by a hinge of fibrous tissue in two cases; in two cases osseous union had taken place; while in two there was a distinct attempt at an arthrodial joint. In Willet and Walsham's case, a woman, aged 31, the bridge of bone was fused both with the scapula and the spine. Union by cartilage with the scapula, and bone with the spine, does not necessarily mean absolute fixation of the scapula, as was proved in *Case* 10 during operation. The bridge is usually attached to

the vertebral border of the scapula, which may project out to meet it, either opposite the spinous process of this bone or a little below it. At the inner end, the bridge is connected with the lamina of one or more vertebræ near the transverse process, so that in some cases a connection, possibly a secondary one, takes place between the bridge and the transverse process. In Willet and Walsham's case the bridge is described as being fused with the spinous process and lamina of the sixth cervical vertebra. It would appear that the extremity of the spinous process, though possibly deviated from the mid-line, is usually not connected with the bridge.

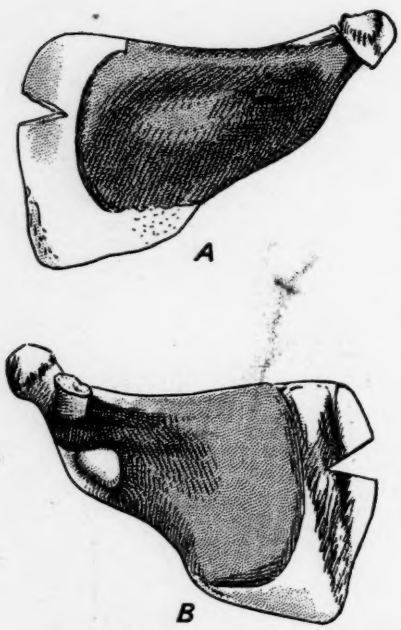


FIG. 374.—*Case* 8. Bridge removed from between left scapula and spine. A, dorsal view; B, ventral view.

In three cases the abnormal bridge was removed by operation. The incision used was in one case T-shaped, and in the other two curved, the convexity of the curve being outwards; the latter incision is the better.* *Fig.* 374 shows the bridge removed in the case of a boy of 7½ years. It measured 2½ in. transversely by nearly 1½ in. vertically. At the scapular end, a small portion of cartilage belonging to the scapula has been removed, and this portion is seen to be connected with the bridge by an imperfect hinge of yellow elastic tissue. At the inner end, two rounded articular processes are seen, the more superficial of which articulates by means of an arthrodial joint with the lamina of one of the lower, (?) sixth or seventh, cervical vertebræ. The other smaller process, situated on the deep aspect of the bone and nearer its upper border, articulated with the transverse process of the same vertebra, the lower margin gave attachment to some strong tendinous fibres which passed inwards and slightly upwards to the vertebra immediately below the one which actually articulated with the bridge. During the removal of this portion of the bone it was found uncovered by anything but skin and subcutaneous tissue. Arising from its upper margin were some horizontal muscular fibres, evidently belonging to the trapezius as in the dissected specimen (*Case* 11). Some vertical muscle fibres were inserted into its lower margin, presumably belonging to the erector spinæ. The deep aspect was practically free from muscular attachment and shelled readily.

Case 10, a child of 19 months, was also subjected to operation, the portion of bone removed being seen in *Fig.* 375. It measured 1½ in. by 1¼ in. The junction with the scapula was by cartilage, which was cut through in the

* *Figs.* 372 and 373 show a case of this kind, the second showing the amount of limitation of elevation of the arm. The position and relative size of the "bridge" can be made out in both.

removal of the bone, no sign of a hinge being present. At the inner end the bridge was fused, i.e., there was bony union, with the junction of lamina and transverse process, this union being divided with bone-forceps. A feature of the case was the extraordinary mobility of the bridge, although absolutely fused with the fifth cervical vertebra. In this case the bone was overlaid by a partly aponeurotic and partly muscular trapezius, some horizontal deeper fibres of which arose from the upper margin of the bridge as in the preceding case. The erector spinæ was attached to its lower margin, and had to be divided, while some fibres passed into its deep aspect, the exact nature of which it was impossible to determine.

A third and last case was very similar to the preceding. The child's age was the same, the deformity was on the left side, while in each there was a dimple just below the spinous process and just outside the attachment of the bridge to the vertebral border of the scapula. In this case (*Case* 17) the trapezius, though obviously not extending downwards to its normal extent, overlapped the upper part of the bridge, and again some fibres were seen arising from the upper margin of this abnormal structure. Some vertical fibres, presumably the levator anguli scapulæ, were attached to the vertebral border above the bridge and to the upper margin of the bridge. These fibres were completely divided. The rhomboideus major was recognized below the bridge, and divided close to the scapula. The superficial fibres of the erector muscle ending in the lower margin of the bridge were divided. The deep aspect was free from muscular attachment, except at the outer part, where apparently some fibres of the serratus magnus arose from it. The cartilaginous union of the bridge to the scapula was divided, the complete clearing of the vertebral border of the scapula being thereby accomplished. The increased mobility the scapula was then capable of was obvious. At the inner end the bridge turned abruptly forwards as a cylindrical process of bone which passed directly into the bony lamina of a lower cervical vertebra near the point of origin of the transverse process. Bone-forceps were applied close to the lamina, and the bridge was removed. When seen recently, the improvement in

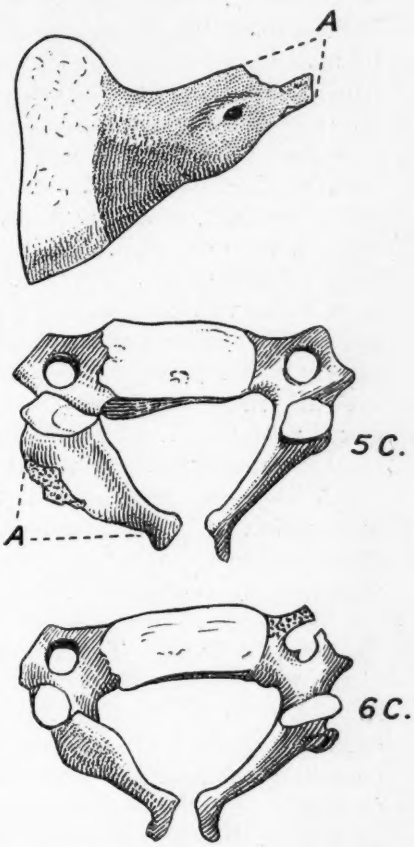


FIG. 375.—Bridge removed from child of 19 months; also 5th and 6th cervical vertebræ obtained later. A marks the position of the attachment of the bridge to the 5th cervical vertebra. Failure of union in the neural arches of both vertebræ is seen.

FIG. 376.—*Case* 17 Bridge of partially ossified cartilage removed by operation from between left scapula and spine.

the relative position of the shoulders was very marked. The appearance of the bridge after removal is seen in *Fig.* 376.

The chief features of the whole series of 18 cases of congenital elevation of the scapula may be summarized as follows. The sex of 8 was male, of 10 female. The right scapula was affected in 6 cases, the left in 9, while in 3 the deformity was bilateral. The scapula was anchored to the spine in 7 cases: in 2 of these, both scapulæ were fixed, in one by a bridge of bone on both sides, and in the other by bone on the right and fibrous tissue on the left. Scoliosis was present in 10. In at least 4 a wedge-shaped half-vertebra was present. In one of these, at the age of two years, there was no curve, but by six years a low dorsal curve, towards or rather below the elevated scapula, and quite unconnected with the half-vertebra, had developed. In 5, the dorsal convexity was directed towards the raised shoulder, in 4 away from it, while in one case with an abrupt curve, both scapulæ were elevated. Partial fusion of ribs was seen in 7 cases, one of these being open to doubt. An unmistakable cervical rib was present in 2 cases only. In 2 there was total suppression of one or more vertebræ, while in 4 cases, including the two just mentioned, there was present a half- or wedge-shaped vertebra. In 3 other cases the shortness of the neck made suppression of vertebræ more than probable, but the difficulties encountered in taking radiograms prevented a definite decision being arrived at. In 2 cases a projection or exostosis was present at the vertebral border of the scapula.

With regard to other deformities present, 3 cases displayed torticollis, two of them having both scapulæ elevated. The radius was absent in 1, the pectoral muscles were imperfect in 2, and facial asymmetry was noted in 2, only one of which was associated with torticollis.

Prognosis and Treatment.—Briefly stated, the prognosis and treatment of the various conditions described above are as follows. In a curvature of the spine due to congenital malformation, exercises and manipulations should be employed as soon as the age of the child permits, with the view of limiting the amount of deformity and preventing the occurrence of secondary or acquired scoliosis. If such acquired curves are already present, and perhaps one shoulder thereby raised, the usual remedial treatment should be undertaken. In deciding the prognosis, it is of the utmost importance that the congenital origin of a portion of the deformity should be recognized, for this portion is usually not open to correction, whereas the acquired curves are, though the presence of the former will render the correction of the latter a matter of considerable difficulty. At any rate, the symmetry of the shoulders and the body generally can be considerably improved. In the cases of congenital elevation of the scapula, the spine always needs careful attention. If no curve is present at first, it may, and indeed is likely to, supervene later, so the closest watch should be kept upon the spine, deformity prevented by drill, and the slightest appearance of curvature checked by special exercises and other means. When congenital scoliosis complicates the elevation of the scapula, it should be treated as already suggested. As regards the elevation of the scapula, treatment never produces a very satisfactory improvement. If a definite bridge of bone or other tissue is anchoring the scapula to the spine, the bridge should undoubtedly be removed, and at the same time any muscles, such as the rhomboids and levator anguli scapulæ, which invite

division, should be cut through. Such an operation will certainly improve the mobility of the shoulder and, to some extent, lessen the asymmetry, but judging from the photographs of reported cases, the result is always far from perfect. In cases in which no definite anchoring tissue can be felt, it is probably inadvisable to perform an operation.

In conclusion, I offer my thanks to those of my colleagues and others whose generosity has enabled me to collect this series of cases. Individual acknowledgement is made in the brief notes of the whole series, appended to this paper. In the majority of the cases the radiograms have been taken by Dr. Ironside Bruce.

BRIEF NOTES OF CASES.

Case 1.—Male. 6 years, under the care of Dr. Lees, 1904, at Hospital for Sick Children, Great Ormond Street. Right scapula elevated. Weakness of lower trapezius and serratus on right side.

Case 2.—Female, 9 weeks, under the care of Mr. H. Stansfield Collier. Bilateral elevation of scapula. Both scapulæ anchored to spine by bridges of bone or cartilage. Right scapula short vertically, left well formed.

Case 3.—Female, 12 years, left scapula elevated. Congenital scoliosis in upper dorsal region, convex to left but with rotation to right. Radiogram shows gross irregularity and fusion of ribs. Facial asymmetry. (Shown at Clinical Society in 1904.) (*Figs.* 366, 367, 368, 369.)

Case 4.—Female, 4 years, right scapula elevated. Slight rotation to right of vertebræ in dorsal region. Almost complete fusion of 1st and 2nd right ribs. On right side, a band ran vertically from a point 1 inch to the right of the occipital protuberance to upper angle of scapula. This felt like a fibrosed muscle, (?) occipito-scapularis muscle. Scapula slightly short vertically. (Shown at Clinical Society in 1904.)

Case 5.—Male, 11 years. Left scapula elevated and anchored to spine by bony bridge. No malformation of vertebræ or ribs. Movements of arms unusually free.

Case 6.—Male, 2 years. Right scapula elevated, short, and having exostosis projecting from vertebral border. No spinal curve when first seen; developed long right dorsal curve later; 2nd dorsal vertebra wedge-shaped, right half being absent, and there being only 9½ dorsal vertebræ all told. Ribs: 10 on left, 11 on right; fusion of 2nd and 3rd, and 4th and 5th ribs on right. Neck very short. (*Figs.* 370, 371.)

Case 7.—Female, 23 years, under care of Mr. Waterhouse at Charing Cross Hospital, for hernia in 1904. Right scapula elevated, well formed. No abnormality of vertebræ or ribs. Transverse processes of last cervical vertebra long, that on left deserving name of cervical rib. (*Figs.* 363, 364.)

Case 8.—Male, 7 years. Left scapula elevated, malformed, and anchored to spine by bridge of bone. Bridge removed by operation at Hospital for Sick Children, Great Ormond Street, in 1908. Scoliosis, left dorsal, right lumbar. Absence of lower fibres of left trapezius. Irregularity 1st and 2nd right ribs. Case lost sight of after operation. (*Figs.* 372, 373, 374.)

Case 9.—Female, 8 years. Left scapula malformed, slightly elevated, and displaying exostosis at vertebral border. Right dorsal scoliosis. Muscles, vertebræ and ribs normal.

Case 10.—Female, 18 months. Left scapula elevated, fairly normal in shape, but anchored to spine by bridge of bone. Skin dimpled over scapula. Bridge removed by operation at Hospital for Sick Children, Great Ormond Street, in 1910. Right dorsal curve in spine below bridge. No malformation of vertebræ and ribs in radiogram. Child died of meningitis. (*Fig.* 375.)

Case 11.—Female, 6 weeks. Case reported in detail above. (*Figs.* 355–359.)

Case 12.—Male, 8 years. Right scapula elevated, slightly short vertically. Partial absence of pectoralis major, and total absence of pectoralis minor, of right side. Slight right dorsal left lumbar scoliosis, but left ribs prominent behind, the right side being distinctly smaller than the left. No abnormality of vertebræ or ribs. (Under the care of Mr. J. Pardoe at West London Hospital, and kindly referred for examination.)

Case 13.—Male, 3 years. Right scapula elevated. No scoliosis. Lower half of pectoralis major absent on the right. Serratus very feeble or absent. Radiogram not taken. Case was lost sight of before full investigation had been completed, so the congenital origin of the deformity is doubtful.

Case 14.—Female, 3 years. Left scapula small and elevated, and anchored to spine by bridge of bone. Left torticollis, with facial asymmetry. Left thumb diminutive. Radiogram not taken.

Case 15.—Female, 3 years. Bilateral elevation of scapulæ. Neck very short, suggesting suppression of cervical vertebræ. Impossible to decide by *x*-rays whether vertebræ and upper ribs normal or not. Left arm small and humerus slender. (Kindly referred by Mr. O. L. Adison.) (*Fig.* 365.)

Case 16.—Female, 17 years. Left scapula normal in shape and mobility, but elevated. Small abrupt congenital spinal curve to left in upper dorsal region, and similar sharp curve to left in lumbar. Third dorsal vertebra wedge-shaped, the right half being absent. Second lumbar mis-shapen. Ribs: 3rd right absent; 5th and 6th right fused for 2 inches; 3rd and 4th left fused for a short distance. (*Figs.* 362, 362*a*.)

Case 17.—Male, 19 months. Left scapula malformed, elevated, and anchored to spine by bridge of bone. Skin dimpled over junction of bridge and scapula, which junction stood out prominently. Bridge removed at Hospital for Sick Children, Great Ormond Street, in 1913. No scoliosis. No mal-development of vertebræ and ribs except (?) fusion of 2 cervical laminæ on left. (Kindly referred by Mr. H. Tyrrell Gray.) (*Fig.* 376.)

Case 18.—Male, 12 years. Left scapula well formed but much elevated. Spine excurvated from 7th cervical to 8th dorsal, and rigid. Anterior end of 3rd left rib very prominent. Right dorsal, left lumbar scoliosis. Radiogram shows half-vertebra, deficiency right 4th rib, and presence of cervical rib on right. (Case kindly referred by Dr. Poynton.)

REFERENCES.

[1] *Trans. Med. Chir. Soc.*, 1880, lxiii, and 1883, lxvi.
[2] *Arch. f. klin. Chir.*, 1891, Bd. 42.
[3] *Roy. Soc. Med., Sect. Dis. of Children*, 1911, April.
[4] *Path. Soc. Trans.*, 1894, 136.
[5] *Ann. Surg.*, 1900, 469.

SEVERE UNILATERAL HÆMATURIA WITHOUT EVIDENT CAUSE.

By GILBERT BARLING, Birmingham.

Dr. Newman's article in the July number of the British Journal of Surgery incites me to record two cases bearing upon symptomless renal hæmorrhage. This condition has long been recognized and spoken of as "renal hæmophilia," "essential renal hæmorrhage," or by some similar term which is meaningless or misleading. Renal hæmophilia, for instance, is misleading, for the condition under consideration has no relation to hæmophilia, in which disease severe hæmorrhage from the kidney may arise, as it may from almost any other organ or part. Accepting renal varix as the explanation of a number of cases of unilateral renal bleeding, and twisted renal pedicle with engorgement of the kidney in others; there still remain some, such as those I record, in which bleeding is so severe as to be really grave; the loss of blood so rapid as to be paralleled only by the most severe hæmorrhages due to a malignant growth involving the renal pelvis; yet no coarse lesion is discovered to explain the loss of blood. Fenwick had not, at the time of my first operation, called attention to renal varix as the explanation of hitherto unexplained renal bleeding, and therefore I may have overlooked such a condition if it were present; but I am perfectly satisfied that it did not exist in my second case. Again, in the first patient renal mobility existed, but at the operation nothing suggested rotation of the pedicle; and a stout, sedentary, rather elderly patient is not the type in whom such a condition is likely to arise; in the second case, the slight degree of renal mobility made twisting of the pedicle impossible.

My cases seem worthy of record because they emphasize the satisfactory results of conservative treatment. The temptation in the first to do a nephrectomy was great, as at that time I had no knowledge as to what was likely to happen if the kidney were replaced in the loin. The length of time which has elapsed since the operations, both patients remaining free from renal symptoms, is also noteworthy.

The control of the renal circulation during section of the kidney is easily obtained by clamping the pedicle with rubber-covered forceps. When these are removed, I believe it is best not to use mattress sutures through the substance of the kidney if they can be avoided; they damage a good deal of renal tissue, and on two occasions I blamed them for severe secondary hæmorrhage after nephrotomies. The method I adopt is to place several mattress sutures in the capsule, to tighten them all simultaneously to take the strain off any individual suture, and then tie them. When this has been done, the clamp should be removed, and the kidney quickly replaced and compressed firmly inside the wound for several minutes with the hand over gauze pads; this I have generally found effective in stopping the bleeding.

Case 1.—Mrs. B., aged 60, patient of Dr. Bernays, of Solihull, was seen in consultation April 27, 1899, for severe hæmaturia of about three weeks' duration, coming on without evident cause, not accompanied by pain, and only by slight frequency of micturition. The blood was well mixed with urine, but the fluid separated into two layers after standing a long time. The bladder had been washed out, and various styptics had been given; but the bleeding, which was quite profuse, had not been influenced in the least degree. The patient was stout, and neither kidney could be palpated.

Cystoscopic examination showed that the bladder was healthy; blood was coming in large quantity from the left ureteral orifice; the right orifice was healthy, and no blood issued from it.

General examination of the urine showed that it had a specific gravity varying from 1,013 to 1,022; it did not contain casts; the quantity varied from 1¾ to something over 2 pints in the forty-eight hours; the urea was estimated, and was generally something over 200 grains in the day, the patient being in bed and on a light diet; no tubercle bacilli were discovered.

There was no previous history bearing upon the patient's condition; the only illness she had suffered was pneumonia some thirty years before.

In the absence of symptoms suggesting renal stone or tubercle, I made a provisional diagnosis of growth, probably sarcoma, of the left kidney, and advised operation.

Operation, *May* 7, 1899.—The left kidney was found freely movable but rather adherent to the perinephritic tissues; the organ itself was small and firm. It was brought out of the wound; but after careful palpation, no diseased condition could be recognized, so the pedicle was secured by a clamp, and the organ freely divided into the pelvis, under the impression that there must be an early central growth. The divided surfaces of the kidney and the pelvis appeared to be absolutely healthy. The capsule was therefore very carefully sutured, and the kidney restored to its bed. There was sharp oozing of blood for a few minutes, but this gradually ceased with firm compression of the organ The wound in the parietes was sutured, and a large drain placed in situ.

The report from Dr. Bernays, three days after, stated that the amount of blood in the urine was much lessened, and it ceased altogether in a short time.

An easy recovery followed, and the patient did not suffer any recurrence of her renal bleeding to the time of her death, which occurred suddenly eleven years afterwards, she being found dead in bed.

Autopsy showed a tumour of the frontal lobe of the brain, into which a large recent hæmorrhage had occurred and, no doubt, caused death. The left kidney was examined and found to be quite healthy.

Case 2.—Mrs. T., aged 47, was admitted to the General Hospital Nov. 25, 1909, suffering from severe hæmaturia. Twelve months before, the patient felt sharp pain in her back, which began all over, but finally settled on the right side over the region of the kidney. The pain would be continuous for two or three days at a time, and then would go almost away, but never entirely. About a month after the pain began, blood was noticed in the urine. Since then the urine has never been free from blood, though the colour has varied a good deal. Sometimes, when much blood has been present, the patient says she has seen black clots in her urine. She has occasionally had a feeling of irritation in her bladder, which, however, has now passed off. She has sometimes had the pain in her back, accompanied by sharp pain round her umbilicus. For the last two or three months she has had very bad headaches, and the hair on the top of her head appears to have come off recently. Ten weeks ago, patient was in this hospital for erysipelas of her face; about three days before that she was unable to pass her urine, and during the time she was in hospital she had to be catheterized. The previous history contained nothing of importance.

On admission, the patient had a constant gnawing pain over her right sacro-iliac synchondrosis; it was very rarely felt higher up, though when very severe might spread all over her back. On examination, the right kidney could easily be felt; it was mobile, not tender nor enlarged.

The patient was very anæmic and feeble, and looked cachectic. The urine contained a large quantity of blood; a few pus cells were present, but no tubercle bacilli or casts. *X*-ray examination of the right kidney failed to show calculus.

Cystoscopic examination showed that the bladder was healthy; blood was escaping freely from the *left* ureteral orifice, none from the right, and both orifices appeared healthy. The right ureter was catheterized; it was patent throughout, and the urine collected from it contained no abnormal constituent.

As in the first case, the severity of the hæmaturia suggested growth of the kidney, although again no enlargement of the organ could be felt. Exploration of the left kidney was performed on December 4. Mobility slightly in excess of the normal was discovered, but no evidence of growth, stone, or other disease on palpation. The pedicle of the kidney was clamped, and the organ completely divided into the pelvis; no evidence of disease was recognized, though the papillæ and the pelvis were carefully scrutinized for varicosities or other vascular changes. The capsule was sutured with mattress sutures, which give a better hold than the ordinary continuous suture, the kidney was replaced and firmly compressed for a short time, and bleeding ceased. The wound was drained.

In a few days the urine was free from blood, and has so remained. The patient resumed her work as a charwoman soon after leaving the hospital, and has continued to do it. When examined recently, four years after her operation, she was in good health and nutrition, and the urine was found to be a normal secretion in all ways.

AN OBSCURE CASE OF ULCERATION OF THE NOSE IN A CHILD, SIMULATING AN EPITHELIOMA.

(A PROBABLE CASE OF TUBERCULOSIS VERRUCOSA CUTIS.)

By DAVID NABARRO, London,
and
T. TWISTINGTON HIGGINS, London.

B. Q., female, aged 11 years, was admitted to the Hospital for Sick Children, Great Ormond Street, on April 21, 1913, under the care of Mr. Edred M. Corner, to whom we are indebted for permission to publish the case.

History.—This was as follows: In September, 1912, a small pimple appeared on the nose. This gradually became larger, and the surrounding skin was discoloured. Dr. B. H. Palmer, of Ramsgate, to whom we are indebted for the history of the case, notes that at this time there was no ulceration present. This occurred later, and the lesion gradually spread. The child constantly picked off the scabs which formed, and so the ulcer became infected. Dr. Palmer treated the case as one of lupus vulgaris, but owing to the difficulty in making a definite diagnosis, he gave the patient potassium iodide as well.

Fig. 377.—From a photograph taken before treatment.

Previous Illnesses.—The child had had measles, scarlet fever, and pneumonia.

Family History.—Negative.

On admission, the patient was a stout, healthy girl. The tip of the nose, and a considerable area of the alæ on either side of it, was the site of an ulcer, the base of which was covered with vascular granulations, bathed in a purulent discharge. There were no outlying areas of ulceration, and no "apple-jelly" nodules.

The disease did not appear to have eroded the nasal cartilages to any extent, and there was no evidence of any extension to the inner aspect of the nostril. No glandular enlargement was detected in either the submental or parotid regions.

Apart from this the child was normal.

The condition of the nose before and after treatment is well seen in the photographs (*Figs.* 377, 378).

Treatment.—On April 23, the ulcer was scraped and cauterized with acid nitrate of mercury. At the operation no erosion of the nasal cartilages was detected. The scraped granulation tissue was at once submitted for examination.

On May 6, *x*-ray treatment was instituted, in the belief that the case was one of lupus vulgaris. We are indebted to Dr. Ironside Bruce for the details of this treatment. Exposures were made at the rate of three a week, the right side being treated one day, the left the next. In all, thirteen exposures were made from May 6 to June 5, filtered radiation being used, the filter consisting of four layers of "table" felt. The tube was placed eight to twelve inches from the skin, and the amount of current 5 milliampères; duration of exposure, five minutes.

FIG. 378.—From a photograph taken after treatment.

Although this treatment was continued for several weeks, the local condition showed little or no signs of improvement. If anything, the ulceration seemed to be spreading, yet the child's general condition remained quite good. In the meantime, the scrapings had been cut, the sections showing the appearances to be described later. They looked like an epithelioma, and this opinion was confirmed by one of our foremost morbid histologists to whom the sections were shown. Such being the case, we obtained Mr. Corner's permission to try the effect of extract of Alnus glutinosa (the common alder), which was introduced several years ago by Dr. Underwood Gray,[1] and which has been used by him in the treatment of malignant disease with apparent success in a considerable number of cases. He claims for this drug that it rapidly diminishes the pain and cachexia which so often accompany malignant disease, and that in some cases it has led to a complete disappearance of the growth.

Dosage.—On the first day, half a minim in water, three times a day after food. On the second day, 1 minim three times daily; on the third day she had 8 minims three times, and thereafter the dose was rapidly increased up to half a drachm of the extract three times daily. The child has been taking this dose now for several months.

Within a fortnight of starting the administration of the alnus the ulcer was

entirely healed, the area was covered with epithelium, and the nose has remained perfectly well ever since. The child was discharged from hospital on July 23, and was last seen on October 29, when the nose looked quite healthy and almost normal. It certainly appeared as if the drug had expedited the cure. Undoubtedly the immediate effects of the *x*-rays were not beneficial. Possibly the cure may have been due to the combined action of the alnus and the *later* effects of the *x*-rays, or, as some may prefer to hold, solely to the later effects of the *x*-rays. There is no doubt that a rapid and striking improvement set in immediately after the alnus was started.

Pathological Investigation.—One of the most interesting features of this case is connected with the microscopical characteristics of the tissue removed by operation, and the pathological diagnosis. This, as we shall see later, has given rise to considerable divergence of opinion among expert microscopists. We propose first to give a description of the appearances presented by the scrapings under the microscope, and then to give the diagnoses of various pathologists to whom the sections were shown. The material submitted for examination consisted of a small piece of what looked like vascular granulation tissue. No normal skin was associated with it, so that it was impossible to say in which direction the sections were cut—whether vertically or horizontally to the plane of the surface. It was hardened in 5 per cent formol in the usual way, and embedded in paraffin. The sections were stained with hæmatoxylin and eosin, by Gram's method, and by Ziehl-Neelsen. We may say at once that no organisms were seen by the last two methods of staining.

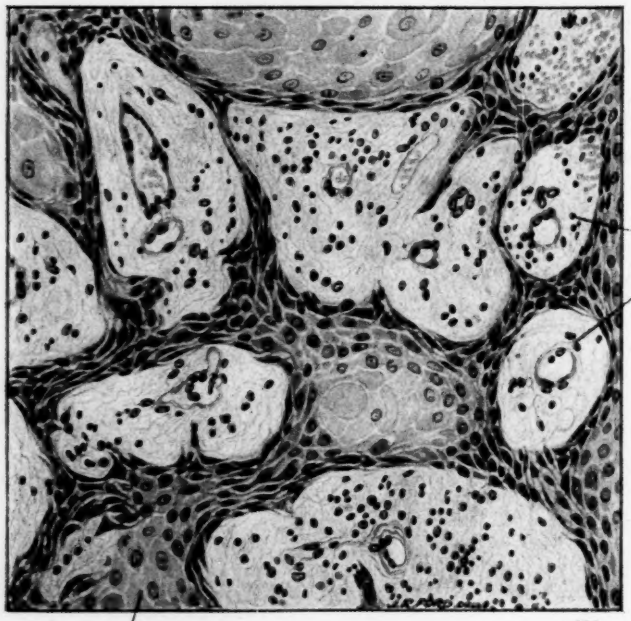


FIG. 379.—The portion of the tissue showing the suggestion of a papilliform arrangement of the connective tissue and epithelial elements. × 165.

The sections stained by hæmatoxylin and eosin presented the appearance seen in *Figs.* 379 and 380. Throughout the section there were large collections or columns of epithelial cells, and in many places typical prickle-cells of the deeper layers of the skin were apparent. In the centre of the larger columns of cells the process of keratinization was very marked, with the formation of characteristic "cell-nests." Many of these cell-nests—though this is not shown in the figures—were invaded, and apparently partially destroyed by polymorphonuclear

leucocytes, and a smaller number of round cells. Between the masses of epithelial cells was a vascular and somewhat cellular connective tissue. In this a number of thin-walled blood-vessels, as well as extravasated blood, were present (*Fig.* 379). In one part of the section the arrangement of the connective tissue was suggestive of the papillæ of the skin, one or two small blood-vessels being seen in the interior of each compartment of connective tissue or papilla (see *Fig.* 380).

An occasional multinucleated or "giant" cell was seen, and a prolonged search failed to discover any mitotic figures in the cells.

Diagnosis.—We think it will be admitted that at first sight the scrapings undoubtedly present the characters of a squamous-celled epithelioma, and this was the original diagnosis made. In view, however, of the tender age of the patient and the happy result of treatment, doubt arose as to the correctness of the diagnosis. The sections were therefore shown to a number of expert morbid histologists, whose opinions are as follows. Two of these said unhesitatingly that it was an epithelioma, even after they had been told the age of the patient and the result of treatment. Another at first called it an epithelioma until he was informed of the patient's age and cure. He then re-examined the sections more critically, and came to the conclusion it was not exactly like an epithelioma, and drew attention to the papilliform arrangement seen in *Fig.* 379. He thought it might be a proliferating papilloma, and that the sections had been cut horizontally across a mass of papillæ. Against this view, it may be pointed out that the larger part of the section does not present this appearance of papillæ cut across, but that seen in *Fig.* 380.

FIG. 380.—General appearance of the tissue removed. Note the large columns of epithelial cells with typical cell-nests. × 60.

Two "cancer" experts were unable to diagnose the sections as cancerous, because it was impossible to say in which direction the sections had been cut. Moreover, no mitotic figures were to be seen. One of them thought it might have been originally a granuloma, with subsequent proliferation of the epithelium resulting from some irritant. Another well-known pathologist expressed the view that it might be malignant, but that the age of the patient and the result of treatment were against it. He, too, thought the disease might have

started as a granuloma, and that the hypertrophy of the epithelial elements was possibly due to some irritation.

Lastly, the sections were shown by one of us (D. N.) to Prof. Fischer, of Frankfurt, who said that they reminded him very much of sections he had made many years ago of a case of verrucose tuberculosis of the skin. He showed his original sections, and the resemblance to the present sections was very striking. There was marked proliferation of the epithelium, and typical cell-nests were present, with pronounced keratinization. In his case, a few tubercle bacilli were seen in the sections. He drew my attention to a paper by Joh. Fabry[2] on "Tuberculosis Verrucosa Cutis," originally described by Riehl and Paltauf. Fabry states that this disease never begins with a "lupus nodule," as lupus itself does, but with a small, brownish-red spot about the size of a lentil, which is covered with small, white glistening scales. On pressure, the redness disappears, soon to return after the pressure is removed. He removed these early erythematous lesions in several cases and cut sections of them. Typical giant cells were already present in this early stage, not only in the superficial layers of the cutis, but also deep down. In addition, he found a very marked hypertrophy of all the layers of the epithelium, the columns of epithelial cells being enormously lengthened (kolossal verlängert) in the cutis, as in epithelioma. With the exception of the presence of many giant cells, which Fabry found in his early cases, the description he gives of tuberculosis verrucosa cutis agrees with that of the present case. The most common situation for the disease is the dorsum of the hand, but cases have been reported in which it appeared in other parts of the body. It occurs most commonly in coal-miners.

We think this case is of considerable interest, and worth putting on record for the following reasons: (1) Its great resemblance to epithelioma under the microscope, so that some pathologists still maintain that it is an epithelioma; (2) The possibility, or even probability, of it being a case of tuberculosis verrucosa cutis, which is an uncommon disease, and in a child must be very rare; and (3) The successful results of treatment.

NOTE BY MR. EDRED M. CORNER (LONDON).

I urged Dr. Nabarro and Mr. Higgins to put this case on record, because it illustrates so well the great difficulties of great pathologists in giving a reasonably certain diagnosis with regard to some carcinomata. For a long time some clinicians have recognized the doubtful value of the microscopist's diagnosis of sarcoma, particularly in children. Dr. Nabarro and Mr. Higgins have now reported most fully an indubitable case in which a similar doubtfulness was shown to exist in the diagnosis of carcinoma by "most high" morbid anatomists. Such a record tells us that cases of the cure of malignant disease cannot be accepted when based upon mere microscopical evidence. The final court of appeal is the clinical court. And if the opinions of that court differ from those of the pathologists, the "casting" vote is with the clinicians. All these considerations thrust increased responsibility on the clinician, who must not rest content with the mere practice of his art, but must keep abreast with and advance *the science of surgery*.

REFERENCES.

[1] Some Notes of Cases illustrating the Effect of Alnus Glutinosa on Cancerous Growths, by T. UNDERWOOD GRAY, *Med. Mag.*, 1907, May; also *Ibid*, 1907, Nov., and 1910, Aug.

[2] Ueber das Vorkommen der Tuberculosis verrucosa cutis (Riehl und Paltauf) bei Arbeitern in Kohlenbergwerken. *Arch. f. Dermat. und Syph.*, 1900, li, 69.

TRAUMATIC SENSORY APHASIA.

By V. ZACHARY COPE, London.

Injuries to the head may give rise to various derangements of memory and speech. Following concussion, there may ensue a general mental dullness, accompanied by slowness and uncertainty of speech and impaired memory; commonly this does not last for more than a few days, and can be attributed to the general effect of concussion on the higher cerebral centres. More definite and serious is the impairment of speech consequent on injury to the specialized centres concerned in that function.

Many cases have been recorded in which motor aphasia has followed a traumatic lesion in the region of Broca's convolution, and it is recognized that the treatment of such cases is operative; but very little attention has been paid to those cases in which the aphasia is of the sensory variety, and due to injury to the region of the auditory and visual word-centres. It may be that the paralysis which is likely to accompany cases of motor aphasia calls attention to the condition sooner and demonstrates more urgently the need for intervention, or more likely the sensory lesion occurs much less commonly than the motor variety; but the fact remains that very few cases of traumatic sensory aphasia have been recorded. In the literature accessible to me I have only been able to collect five cases, and any opinions put forward here are based on these and on my own case recorded below.

The clinical history of a case of traumatic sensory aphasia may be one of two types. Nearly always, concussion, either slight or severe, follows immediately after the injury. Unconsciousness may last for anything from a quarter of an hour up to eight days.

In the first type of case, the aphasia is noticed as the patient recovers from the unconscious state; in the second variety there is a latent period between the recovery from unconsciousness and the observance of speech defect. In the case recorded by Dr. Kinneir Wilson, the patient left the hospital apparently well the day after the injury, but two days later returned in a half-dazed condition and unable to express his thoughts. In one case, no mention is made of unconsciousness, but it is stated that the speech defect came on gradually.

The further course of a case, if left without operative treatment, is variable. Considerable improvement occurs within a few weeks, and in a few months the patient may be put down as "recovered," but some defect of memory or speech commonly remains, and in one of the recorded cases hardly any improvement took place for the two years the patient was under treatment.

The prognosis is bad as regards the complete recovery of the function of speech if the case is treated on expectant lines. Recovery ought to be more complete in children, since in them the opposite side of the cerebrum would more readily compensate for the injured side.

Attention must be drawn to the fact that epileptiform fits occurred some time after the injury in two out of the three cases treated expectantly.

In one instance death resulted from the status epilepticus some years after the injury.

The condition may be caused by direct violence applied over the left parieto-occipital region, or by contre-coup injury from a blow on the right side of the cranium. In one case it was due to a penetrating wound over the region of the superior temporal gyrus on the left side. In Heiligtag's case there was accompanying fracture of the skull, but no record of depression of bone.

Since there is no record of depressed fracture in any recorded case the actual lesion causing the condition must have been either hæmorrhage leading to pressure over the sensory centre for speech, or laceration, cortical or subcortical, of that area of the brain.

It has been contended by Phelps that pial hæmorrhage by itself is not sufficient to cause speech defect. He asserts that if any hæmorrhage localized in some part of the speech zone proves to be of cortical origin, it must still be regarded as a concomitant rather than a causative factor in production of the speech defect. Whilst admitting that in most cases of pial hæmorrhage there is some superficial cortical contusion or laceration, it appears more likely that traumatic sensory aphasia is, as a general rule, caused mainly, if not solely, by the pressure of blood-clot over the cortical sensory speech centres; this view receives support from the six cases under discussion. In the two patients operated upon, the removal of the clot caused immediate cure of the condition; in a third (Heiligtag), a pulse-rate of 60 and a headache persisting after eight days of unconsciousness suggest increased intracranial pressure. Dr. Kinneir Wilson's patient showed a marked latent period between the recovery from the concussion and the development of the aphasia; this is in keeping with the occurrence of hæmorrhage, and the latent period suggests a comparison with that which occurs in middle meningeal hæmorrhage. In the other two cases also, the account given appears to indicate an interval before the symptoms of aphasia developed. On *à priori* grounds it appears more likely that hæmorrhage rather than cortical laceration would give rise to sensory aphasia unaccompanied by other lesions, for a cerebral contusion extensive and severe enough to put the sensory speech-centres out of working order would be likely to injure the kinæsthetic area or the hemianopic cortical centre, while it is comparatively easy to imagine a single ruptured pial vessel causing an accumulation of blood that would give rise to considerable direct pressure over the speech centres; such hæmorrhage would tend to stop naturally when the pressure had reached a certain limit. The continuous pressure would in due time cause permanent changes of the underlying cortex.

Treatment.—The line of treatment to be adopted follows from the view which is taken as to the cause of the condition. If the cortical or subcortical laceration is the main etiological factor, expectant treatment is indicated. On the other hand, if pressure of the blood-clot is the main cause, it seems clear that the skull should be trephined, the dura opened and the clot removed. The trephine opening should be made about two inches above the left external auditory meatus, and more bone may be removed in a backward direction if necessary. The subdural region should be explored carefully by a flat dural separator, and there should be no hesitation in incising the subcortical region

for clot if none be found superficially. To illustrate this line of treatment I here relate the case which came under my observation and treatment.

AUTHOR'S CASE OF TRAUMATIC SENSORY APHASIA, TREATED SUCCESSFULLY BY TREPHINING AND REMOVAL OF CLOT.

Ellen B., aged 14, was brought to the Bolingbroke Hospital about eight o'clock on the evening of August 14, 1913, with the history that she had fallen down a flight of six steps and struck the back part and left side of her head against the step or

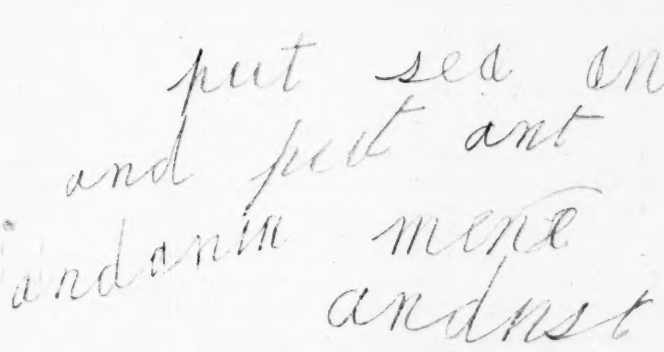


FIG. 381.—Spontaneous attempt at writing.

ground. The accident had occurred three hours previously; during the intervening time she had been semi-conscious and had vomited frequently. Up to the time of the accident she had been a lively and intelligent girl in full possession of her faculties.

When admitted, the patient's temperature was normal, pulse 76, respirations 16 per minute. She lay with eyes closed, but when approached opened them and said, "Don't hurt me, daddy," and repeated the word "daddy" frequently during the initial examination. She had no recollection of the accident, and with difficulty told of her doings that day. At the same time she continually relapsed into a more drowsy condition; her eyeballs kept rolling upwards.

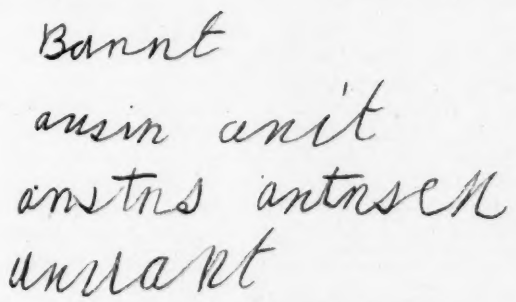


FIG. 382.—Spontaneous attempt.

There was an abrasion and a very small scalp-wound behind and above the left ear. There were no signs of fracture of the skull-base, and no paralysis of cranial or peripheral nerves. The pupils were of normal size and reacted to light; the knee-jerks were elicited and the plantar-reflex was normal.

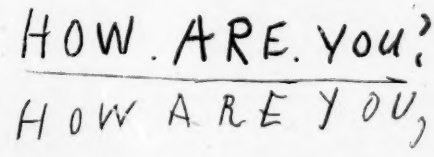


FIG. 383.—Attempt at copying capital letters.

Her condition did not improve; she remained in an irritable state, curled up on her right side in bed, and resented any interference. Vomiting occurred several times. She spoke no word spontaneously, but apparently heard what was said to her. At first her condition was taken to be that of simple concussion and cerebral irritation. Gradually, however, her pulse became slower, till it was about 50 per minute, whilst

her mental condition remained anomalous, in that she seemed fully conscious yet did not utter a word. On August 19, when I saw her first, the condition was much as described above. There was no paralysis, but I could not elicit the knee-jerks; there was some photophobia; the pupils were equal, slightly dilated, and reacted to light normally. Ophthalmoscopic examination showed congestion of the retinal vessels and blurring of the edges of the disc.

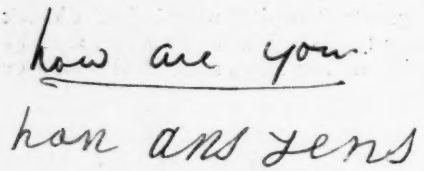


FIG. 384.—Copying small letters.

On the next day (Aug. 20) the aphasic condition was more fully investigated by my house-surgeon (Mr. O. R. L. Wilson), to whom I am indebted for these notes.

The only word she could be got to utter spontaneously was the nick-name of her sister, and this name, "Doodles," she repeated throughout the examination. She gave plenty of indication that she understood at least some of the words spoken to her, but could not answer any question intelligibly, a jumbled mutter being all that she could attempt. She was unable to repeat words spoken to her.

She did not understand written questions or commands, though it was clear she saw them. She was able to write spontaneously, but her writing was disconnected nonsense. She copied capital letters correctly, but came to grief when attempting to copy ordinary handwriting.

She was unable to write from dictation, nor could she name objects seen. Reading aloud from printed or written matter was not in her power, and she was unable even to pick out objects of which the name was given to her by speaking.

She readily understood pantomimic gestures, and imitated them. She appeared to appreciate the use of some but not all objects shown to her.

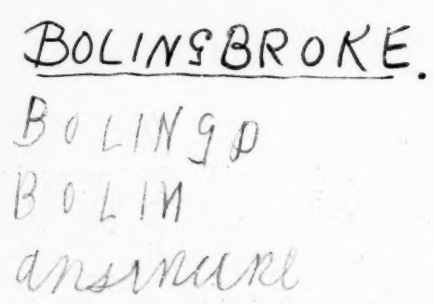


FIG. 385.—Copying.

From the above examination it was evident that there was some serious lesion in the higher centres for understanding both printed and spoken words, but especially affecting the visual higher centres.

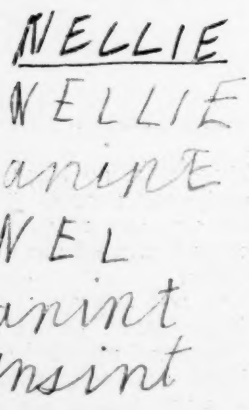


FIG. 386.—Copying.

On August 21, operation was undertaken. A horse-shoe-shaped flap was made with its base above the left ear. The trephine was placed so that the centre-pin was two inches, or a little more, above the external auditory meatus. No clot was found outside the dura, which was tense, bulging, and non-pulsatile. When the dura was incised a small amount of dark blood was found underneath. By carefully searching in every direction under the dura by means of a flat metal instrument, a considerable amount of old black blood-clot was discovered in a direction towards the occipital lobe. This clot escaped under considerable tension—it leapt out—and altogether several drachms came away. Some more bone was removed in a backward direction and careful search made for further extra- or intradural hæmorrhage, but no more clot was found. The cerebral cortex was also explored by needle and knife, but no subcortical hæmorrhage was found. The dura was sewn up with thread and the skin flap replaced and sutured with silk-worm gut without drainage. The pulse at the end of the operation was 100; at the beginning it had been 50 to the minute.

Recovery of speech after the operation was exceedingly quick. The next day

the patient asked for some dinner, and in general showed a marvellous improvement. Within a week, practically all her disabilities were removed, and instead of the stolid, non-comprehending countenance, was the intelligent, mobile face, readily smiling, and appreciating every remark made to her.

So far as I can ascertain, this is the first case in Great Britain to be trephined for traumatic sensory aphasia.

PREVIOUSLY RECORDED CASES.

Case 1.—(BEEVOR.) *Vide Lancet*, 1893, i, 726.

A man, aged 50, fell fourteen feet, and became unconscious for a quarter of an hour. Next day he was drowsy and could not talk; there was no definite palsy. Spontaneous speech was imperfect, and though he understood spoken commands, he talked nonsense. He wrote spontaneously, but could not understand written commands. He could neither repeat words spoken to him, nor pick out objects named, nor write from dictation. He could not copy printed characters, nor was he able to name objects shown to him, though he could recognize their use.

The lesion was diagnosed as probably concussion or hæmorrhage over the visual word-centre.

Recovery is stated to have occurred within three weeks; but memory remained impaired, especially that of names of people and things; moreover a fit occurred during recovery, and another somewhat later than the time the case was reported.

There had been a scalp wound two inches above the external auditory meatus, and Beevor at the time said, "If therefore it had been necessary to operate, I think it would have been advisable to trephine at the scar over the region of the first temporo-sphenoidal convolution, and if nothing were found, to work backwards and upwards."

Case 2.—(MACVICAR.) *Scott. Med. and Surg. Jour.*, 1898, iii, 407.

A painter, aged 26, on December 27, 1897, struck his head against the edge of a dresser whilst under the influence of drink. There was an injury over the right parietal eminence. For two or three days the symptoms were those of ordinary concussion, but on December 30 his wife noticed that his speech was much altered. He could point out anything named, but failed to name most things at sight, though on a wrong name being suggested he repudiated it. He understood all that was said, but nothing written. He could copy print and could write his own name, though he could not name the letters after he had written it. He was blind to figures, completely letter-blind, but not absolutely word-blind.

The patient was given 7-gr. doses of potassium iodide and gradually recovered. The visual word-centre took fourteen days to recover as regards words, and nineteen for numerals. Four months after the accident the patient could write a short letter correctly and read fluently.

MacVicar stated, "It is probable that the nature of the lesion was a hæmorrhage, either single, or multiple minute hæmorrhages. The disturbance of the brain as a whole, through the medium of the cerebro-spinal fluid, was evidenced by the severe symptoms of concussion, the short unconsciousness with some delirium, the persistent vomiting, headache, and slowed pulse, from which he took some days to recover."

Dr. MacVicar has kindly informed me that the patient, several years after the relation of his case, came under treatment in hospital in a condition of status epilepticus. The fits continued till death, which supervened about twelve hours after admission. A post-mortem was granted. Softening, cortical and sub-cortical, was present in the areas mentioned in the case.

Case 3.—(KINNEIR WILSON.) *Brain*, xxix, 416.

Patient (a man) fell from a cart and injured the left side of his head. He remained over-night in military hospital in a more or less unconscious state, but left next day apparently well. Two days later, he returned in a half-dazed condition, quite unable to express his thoughts.

His condition when under observation was as follows: no hemianopia, slight weakness of right arm, sensation unimpaired.

Speech: excellent articulation and phonation.

Little word-deafness. Great word-blindness.

Cannot repeat a single syllable to order. Can sing tunes well, frequently with words. Can whistle accurately. Cannot write or read. Can copy written and printed language.

Cannot read what he has copied. Can draw well.

Cannot name objects, but indicates their use perfectly. No apraxia or mind-blindness. Pours out a torrent of words and nonsense in conversation.

Dr. Kinneir Wilson has kindly informed me that the patient's condition remained *in statu quo* for the two years during which he was under observation.

Case 4.—(HEILIGTAG.) *Deut. Wochensch.* 1910, xxxvi, 2147.

A man, aged 25, on November 4, 1909, was struck on the head by a stick. He had a wound over the region between the left parietal and occipital bones. Also a fracture. Another wound on the right side in a corresponding position.

Patient unconscious; vomiting occurred, and there was slight fever for a few days. Pulse 110, but came down to 60. Remained unconscious for eight days. Complained of headache after wound had healed. Could not read, but could write and speak. This condition was diagnosed as subcortical alexia, and operation was intended, but Dr. Heiligtag writes in March, 1914, that the patient refused operation, and that the clinical symptoms of the case are about the same as at the time of publication.

Case 5.—(BALL.) *Dublin Jour. of Med. Science*, 1888, Sept., 243.

Patient, aged 26. Ten days before admission was struck on the head by a penknife in the left temporal region. Gradually found difficulty in using correct words. The external wound healed. He was able to write his name correctly and to copy writing, but was unable to write from dictation or from sentences which he originated himself. Could not read. Word-deafness partial. No paralysis.

Five days after admission operation was performed. Wound of the squamous portion of temporal. It was found that the knife had penetrated the dura. Dark-coloured blood extruded. Clot removed. Drainage.

Much better the same evening. Worse next morning, but on removal of drainage tube he improved.

The recorder of the case commented, " In this case, I believe the knife penetrated the superior temporo-sphenoidal convolution, traversed the fissure of Sylvius, and probably injured Broca's convolution; and that his symptoms were due to a blood-clot in the fissure of Sylvius which was breaking down."

It is quite clear that injury or pressure over the superior temporo-sphenoidal convolution would have accounted for all the symptoms of this case.

CONCLUSIONS.

1. Traumatic sensory aphasia is often, if not generally, due to subdural hæmorrhage pressing on the cortical sensory speech centres.

2. The aphasia affects the visual more than the auditory speech-centre.

3. If treated expectantly, recovery is generally incomplete, and there is a risk of epileptiform convulsions developing later.

4. Treatment by trephining and removal of the clot is the best course.

MASSIVE COLLAPSE OF THE LUNG.

(*Syn.* ACTIVE LOBAR COLLAPSE.)

BY W. PASTEUR, LONDON.

DEFINITION.—Total deflation (as opposed to lobular or patchy collapse) of a large area of lung tissue, of sudden onset—in the absence of any signs of obstruction of the air-way or of any known cause of compression,—due to failure of inspiratory power and attended by definite physical signs and symptoms.

The interest of the condition to surgeons lies in the fact that it not unfrequently complicates abdominal operations or injuries of the trunk and that it throws some light on the nature of post-operative lung troubles.

Definition of Terms.—Much confusion has arisen from the careless use of the word "collapse" in relation to states of the lung. It should only be used to indicate the condition in which a lung, or part of a lung, is completely deprived of its air content. The expression "partial collapse" is misleading and should be replaced by "partial deflation."

Partial deflation of the pulmonary bases is met with in a variety of conditions, e.g., after abdominal operations, in the bedridden, etc., and it signifies loss of efficient inspiratory force. It has little or nothing in common with collapse, either clinically or anatomically, but it is doubtless a predisposing cause of patchy collapse of the bases.

Massive collapse, of which this article treats, differs from patchy collapse both in its mode of origin and in its clinical features. It is probably always determined by grave failure of inspiratory power, and there are two well-defined varieties of the condition: (1) Cases in which the lesion is demonstrably due to paralysis of some of the essential muscles of respiration (diaphragm, intercostals, etc.), the collapse being often bilateral; (2) Cases in which collapse supervenes suddenly, without any premonitory signs of respiratory paralysis, and in which the lesion is apparently always unilateral. This group includes all cases of post-operative and traumatic collapse.

As failure of inspiratory power is the essential cause of massive collapse, it is desirable, by way of introduction, to refer briefly to the mechanism of respiration to make quite clear the *modus operandi*.

In recent years our views on this subject have undergone considerable change. We now attach more importance to muscular action in expiration than formerly, and correspondingly less to lung elasticity and elastic recoil of the ribs. The appreciation of the structural differences between the ribs above and below the sixth pair, which are intermediate in structure, has emphasized the fact that the upper ribs act directly on the lungs, whilst the lower affect mainly the abdominal wall. In the words of Keith, to whose work we are largely indebted in this matter, "The upper set of ribs is seen to be raised by a bucket-handle movement, thus expanding the chest laterally. The lower set undergo

no such movement; they are long levers articulated at their vertebral ends; when their ventral ends are raised they lead to a great lateral enlargement of the abdominal wall, but only to a very partial enlargement of the real pulmonary space. That is to say, while the upper set are direct lateral distenders of the lung, the lower are made accessory to the diaphragm. They provide a fulcrum for the diaphragm; and their lateral movement is designed to make room for the abdominal viscera displaced by this structure, rather than cause a direct enlargement of the lung." The direct distender of the bases of the lungs is the diaphragm, which also exerts its influence with diminishing intensity as high as the apex of the lung.

It may therefore be stated in very general terms that the expansion of the lungs takes place under the influence of two forces, and that the overlapping between their respective spheres of action roughly corresponds to the position of the great fissure, the costal force acting mainly above and the diaphragmatic force mainly below it.

MASSIVE COLLAPSE FROM RESPIRATORY PARALYSIS.

The effect on the lung of failure of respiratory power is best studied in cases of paralysis of the muscles of respiration. My attention was first directed to the subject many years ago when, during a severe epidemic of diphtheria in the east of London, I saw many cases of post-diphtheritic paralysis in the wards of the Queen's Hospital for Children. In a paper[1] based on 34 consecutive cases of the condition, I came to the conclusion that paralysis of the diaphragm or other parts of the chest wall tends to induce loss of function in the subjacent lung, which is, *cæteris paribus*, proportionate to the degree of paralysis, and results in more or less collapse and œdema of the pulmonary tissue. Subsequent experience has confirmed and extended this opinion.

It will be seen in due course that the clinical signs of massive collapse following an operation are in the main identical with those presented by cases of diphtheritic paralysis of the diaphragm; and the importance of this resemblance is in part owing to the fact that in the latter group a knowledge of the accompanying pathological state of the lung is readily obtainable, whereas most cases of post-operative massive collapse terminate favourably.

The two following cases afford a good illustration of the clinical picture in post-diphtheritic paralysis of the direct distenders of the lungs.

Case 1.—**Massive collapse of right lung.**

Joseph H. Admitted to hospital in May, 1886, with widespread paralysis of the trunk and limbs. During the first fortnight the paralysis became more profound, and cough ineffectual and non-explosive. The movements of the ribs appeared to grow less day by day. On the seventeenth day, respiration suddenly became embarrassed, with dusky lips and cold and bluish extremities. With the exception of the two or three upper ribs, the right chest was immobile. Percussion impaired all over right front; back not examined. Breath sounds loud and tubular over upper lobe, weak over middle lobe, inaudible over base. No pain. Temperature 99·4°.

Next day the child was weaker: tubular breathing without râles all over right front. Breathing exaggerated over left lung. Heart not displaced. Reversed feeble movements at epigastrium. Temperature 100°. Pulse 144, thready. During

the next two days the general condition became worse, and the temperature gradually rose to 102·4°.

On the twenty-first day, four days after the onset of respiratory symptoms, there was a rather sudden change for the better. This was accompanied by a return of movement in the right chest, and a rapid disappearance of the signs of diaphragmatic paralysis. The back, examined for the first time, showed broncho-tubular breathing over the right apex and posterior apex of the lower lobe, with distant weak breathing at the right base and exaggerated breath-sounds over the left lung.

On the twenty-fifth day, the two sides of the chest moved equally, and three days later the breathing at the right apex had lost its tubular quality. The patient made a good recovery.

The second case, which was brought to my notice some years later, when I was on the point of publishing the paper referred to above, is of interest, not only on account of the very unusual limitation of respiratory paralysis to the distenders of the upper lobes, but because Pearson-Irvine, who reported the observation in 1876, definitely states that in his opinion "the physical changes observed in the lungs were the result of paralysis of the muscles concerned in the elevation and expansion of those parts."

Case 2.—**Massive collapse of both upper lobes.**

Y. W., a girl, aged 6, fell rather suddenly ill, with short frequent cough and considerable dyspnœa, four weeks after an attack of diphtheria. She was feverish for the first two or three days, but had suffered no pain.

When first seen, fourteen days later, she was dull and listless, with drooping head and a queer look about the eyes. Temperature was normal; respirations (14) shallow, slow, but not laborious. She had continuous cough, as though to clear the throat. There was decided flattening of both infraclavicular regions, with almost complete absence of movement. It appeared as though the upper part of the chest had fallen in. The bases expanded unusually fully, and there was a strong action of the diaphragm. There was loss of resonance above and below the clavicles as low as the third ribs, and dullness in the supraspinous fossæ, but the rest of the back was resonant, the bases abnormally so. Every variety of bronchitic râle could be heard. At the apices there were loud sonorous râles, not concealing what seemed to be true tubular breathing.

Beyond an increase of the paralysis of the trunk and limbs, there was no change in the lung condition during the next seven days. But a week after this there was a striking change. The head was all but erect, the walk was no longer ataxic, and the child was quite cheerful. The improvement occurred quite suddenly. There was increase of resonance at the apices; the breathing was still tubular at the right apex, weak elsewhere. No râles to be heard anywhere. The upper thoracic zone still moved imperfectly. A fortnight later she was to all appearance quite cured.

The appearances met with post mortem are even more striking. In a series of 64 cases of post-diphtheritic paralysis observed by myself, the diaphragm was involved no less than twenty-eight times, with a fatal result in 15 cases. An autopsy was performed in 8 of these. In 5 there had been clear evidence of paralysis of the diaphragm for several days before death, and in each of these the right lower lobe was completely collapsed, sinking entire in water, of a deep blue colour, and entirely devoid of air. The left lower lobe was in a similar but usually less advanced state of deflation. In one of the cases, the right upper lobe also was totally collapsed, with the exception of the tip of the apex.

On section in 2 cases there were lighter patches of broncho-pneumonia

scattered through the lower lobes. In the remaining 3 cases there was no massive collapse. In one of these broncho-pneumonia was diagnosed, but there had been indefinite signs of diaphragmatic failure. In the second there had been no suggestion of diaphragmatic paralysis, whilst in the third, undoubted signs of paralysis of the diaphragm had disappeared at least twenty-four hours before death.

The evidence from these cases is conclusive as to the effect on the lungs of complete arrest of diaphragmatic action, and confirms the view that the expanding force of the diaphragm is exerted mainly on the lower lobes. It will suffice to mention here that the physical signs in cases of diaphragmatic paralysis may somewhat closely resemble those of consolidation of the pulmonary bases.

Massive collapse in respiratory paralysis may be explained as follows. As the expansion of the lungs at birth is primarily due to muscular effort, and is subsequently maintained by the balance between the forces which respectively cause expansion and contraction, it follows that whenever—whether as the result of paralysis or of temporary inhibition—the distending force acting on any part of the lungs becomes less than that of the agencies which tend to cause it to contract, these latter, so to speak, take charge, with the result that the part of the lung concerned rapidly empties itself of its contained air. It is to be noted that the mechanism here suggested—active contraction—differs from that generally accepted in explanation of lobular or patchy collapse, namely, gradual absorption of the contained air from a portion of lung which has been shut off, by occlusion of the air-way, from communication with the external air.

POST-OPERATIVE MASSIVE COLLAPSE.

We have now to consider the bearing of these observations on post-operative lung complications. I should have hesitated to address my surgical confrères on this aspect of the matter, had not the kindness of my surgical colleagues at the Middlesex Hospital enabled me to study many instances of these accidents in their wards during the last six or seven years.

Excluding one or two very rare accidents, it is safe to say that all post-operative lung complications have hitherto been classed under one of the following heads: pneumonia and broncho-pneumonia, bronchitis, pleurisy, and pulmonary embolism and infarction. I propose in this paper to deal with the first group only, the one concerning which there is still most confusion and uncertainty.

There are two points in relation to post-operative pneumonia which deserve notice: first, it nearly always occurs after operations on the abdominal cavity or in its immediate neighbourhood; and secondly, the bases of the lungs are especially liable to be affected.

I do not propose to examine the various explanations that have been advanced from time to time to account for post-operative pneumonia. In my opinion there are only two essential factors, which may act independently or in combination to produce lung symptoms. The one is access of infective material to the lung; the other, serious lessening or temporary arrest of respiratory power.

Infective material may reach the lung in two ways: either through the lymphatic or general circulation, as in cases of general sepsis, where the lung lesion is usually a widely disseminated broncho-pneumonia; or by aspiration of

mucus and buccal secretion into the lungs during anæsthesia. I have the impression that when broncho-pneumonia arises from the latter cause it is often limited to the posterior and basal portions of the lungs, i.e., to those parts of the organs which are most directly affected by the lessening of the respiratory power of the diaphragm. I have been struck by the comparatively small amount of care bestowed by some surgeons on the preparation of the patient's mouth before operation, as compared with the infinite precautions taken to defend him from septic invasion in every other direction. I am told that, even now, some surgeons perform laparotomy with a light heart on a patient whose mouth is literally a storehouse of septic material. Be this as it may, I am convined that greater attention to this point in preparation must lead to an appreciable diminution in the frequency of post-operative bronchitis and broncho-pneumonia. I have elsewhere dealt in some detail with this side of the subject.[2]

It is instructive to learn that since the practice of giving an injection of morphine and atropine before anæsthetising has become general at the Middlesex Hospital, there has been a striking disappearance of respiratory difficulty (hypersecretion and aspiration) during anæsthesia, and a corresponding diminution of post-operative bronchial complications after major operations.

The other essential factor requires closer consideration. When I began to examine patients suffering from " post-operative pneumonia," I soon realized that the signs and symptoms they presented were not quite on all fours with those of lobar pneumonia as met with in medical wards. Although the physical signs might be indistinguishable, the symptoms and course of the affection were frequently different. The fact that this " pneumonia " was so frequently situated at the right base, led me to suspect that it might be massive collapse rather than pneumonic consolidation. At that time I was under the impression that the collapse of the lung might be caused by weakening of diaphragmatic power consequent on the abdominal section, and in order to determine, if possible, to what extent diaphragmatic movement could be inhibited in this way, I examined some patients under *x*-rays shortly after laparotomy.

Four clean, uncomplicated appendicectomy cases were screened on the fourth day after operation. In three of them the diaphragm movements were normal, but in the fourth there was no respiratory excursion whatever of the diaphragm in ordinary breathing, whilst in forced inspiration the maximum excursion was 7 mm. instead of 30 mm. As this patient was known to have breathed normally before operation, this observation, even though at present it stands alone, proves that the operation of laparotomy is capable of interfering with diaphragmatic action to a very serious extent. But the patient did not have massive collapse, and beyond the fact that there was weak breathing at the bases for a few days, and that convalescence was slightly prolonged, the case ran a perfectly normal course. I am not satisfied, on the evidence at present available, that this post-operative protective limitation of diaphragmatic movement ever leads on to massive collapse, though it offers a complete explanation of the weak breathing at the bases so often met with after laparotomy.

But there is even stronger evidence, from the clinical side, that the lung lesion is collapse and not consolidation.

The following description of the clinical varieties and symptoms of lobar collapse is based on the observation of some thirty or more examples of the

condition. The surgical records of the Middlesex Hospital furnished no examples of massive collapse before 1908, when I first drew attention to the condition,[3] but since that time there has been a gradual increase in the number of cases observed, and a corresponding diminution in those of post-operative pneumonia. There is much more in this than a mere change of name, for the diagnosis of massive collapse is never made unless there is displacement of the apex-beat towards the affected lung, a physical sign which could under no circumstances accompany a lobar pneumonia. In saying this, I do not for a moment wish to convey the impression that all cases of pneumonia following an abdominal operation are in reality instances of massive collapse; but the opportunities I have had of seeing many post-operative troubles lead me to believe that true lobar pneumonia is of somewhat rare occurrence. Pneumonia following an operation is generally patchy. Indeed, I would go so far as to say that when physical signs, especially at the right base, suggest pneumonia, the odds are in favour of massive collapse.

CLINICAL FEATURES OF MASSIVE COLLAPSE.

Although the onset is probably sudden in every case, there are two well-defined clinical types—acute and latent. There are two forms of the acute type; in one, which is rare, the initial dyspnœa is of such intensity and suddenness as to suggest pulmonary embolism or pneumothorax; in the other and commoner form the symptoms resemble, sometimes those of acute pneumonia, occasionally those of heart failure, and more rarely still a combination of the two. In the latent type there may be a complete absence of symptoms, although the physical signs are generally well developed. Such cases may easily escape detection if the backs are not examined. In our experience at the Middlesex Hospital the complication is rarely, if ever, fatal in cases which remain surgically clean. In some septic cases the onset of the complication appeared to precipitate a fatal issue. In the few cases I have had the opportunity of examining post mortem, the condition of the lower lobe (right) was exactly similar to that described in the early part of this paper, as the result of paralysis of the diaphragm.

The physical signs commonly met with are dullness over the affected base, sometimes extending upwards into the adjacent lobe: silence or tubular breathing over the dull area, usually without râles and with diminution or loss of vocal vibration in many cases: very imperfect movement of the affected side of the chest, which is nearly always reduced in girth, and vigorous compensatory action of the opposite side, with exaggerated breathing. Pain is often present for a short time at the outset; it is deep-seated, in the lower part of the chest, and less acute as a rule than the pleural pain of pneumonia. The occurrence of viscid expectoration is an early symptom in most cases. The sputum at first probably consists of mucus pressed out of the collapsing lobe; but if expectoration continues longer than thirty-six hours, there is probably bronchitis or broncho-pneumonia in the re-expanding lobe or in some other part of the lungs. The onset of collapse is nearly always accompanied by definite pyrexia, the temperature sometimes rising to 103°, or even higher. The reason of this is obscure, but pyrexia does not necessarily indicate the presence of inflammation in the lung. It is comparable to the rise of temperature met with in pulmonary infarction.

But by far the most important sign of massive collapse is the displacement

of the heart's apex-beat towards the affected lung. It is probably the only sign peculiar to the condition, and is always present when the collapse is unilateral, and sufficient in degree. It cannot well occur when both bases are involved simultaneously, which explains why it has not been met with in diaphragmatic paralysis after diphtheria. I have never met with a post-operative case in which the physical signs suggested that both bases were collapsed.

The physical signs of this dislocation of the heart are generally obvious. In right-sided collapse the superficial cardiac dullness is obliterated and the apex beat is carried inwards towards, or even across, the median line. In left-sided collapse it is displaced outwards into the left axilla.

The diagnosis of massive collapse cannot be made with certainty in the absence of this sign.

The mechanism of the displacement is probably as follows. When the affected lobe begins to contract, the contiguous costal and diaphragmatic surfaces fall in behind it, as far as anatomical relations will permit. Beyond this point the occurrence of negative pressure on the affected side of the chest can only be prevented by the displacement towards it of the mediastinum, with complementary enlargement of the healthy lung, of which there is always physical evidence.

The exact nature of the *genesis* of post-operative collapse must, for the present, remain a matter for speculation. As already stated, there is no evidence that post-operative protective limitation of diaphragmatic movement ever leads on to collapse, which, if due to that cause, would of necessity be bilateral. On the other hand we may conclude with certainty, from the evidence brought forward, that failure of respiratory force is the essential cause of massive collapse. We are therefore led to the conclusion that post-operative massive collapse is the result of (reflex) arrest of action of one half of the diaphragm.

On this hypothesis, a stimulus of unknown nature arising in one half of the body reflexly arrests the distending action of the corresponding half of the diaphragm, to such a pitch that the " compressors " of the lower lobe of that side " take charge," causing it to collapse in the manner already described. One may hazard the conjecture that the afferent path of the reflex is along some branch of the vagus, for, in all the cases within my knowledge, the initial disturbance, whether trauma, disease, or surgical interference, has always lain either within, or in close contiguity to, the area of distribution of some branch of this nerve.

Injury of a nerve during operation, either by division or inclusion in a ligature, suggests itself as a possible starting-point for the reflex. In this connection the opinion of one of my surgical colleagues is worthy of mention. He believes that massive collapse is more often met with after large incisions through the abdominal wall, especially when the muscles have been cut through, than after small incisions, with little or no injury of muscles. This may be the case, but collapse may certainly follow a small incision: it may indeed occur after an operation altogether away from the abdomen, as after thyroidectomy. An important point to settle is whether the measures now being taken to diminish or prevent shock after major operations have any influence on the incidence of post-operative collapse. Another observation, which may eventually throw some light on the subject, may be referred to in this place. Weak breathing, at one

or other base, is not infrequently detected before operation, especially in appendix cases. It will be interesting to ascertain whether patients who present this symptom are more prone to collapse than those who do not. This observation, moreover, seems to establish the important fact that disease within the abdomen may cause unilateral limitation of diaphragmatic movement.

There are exceptions to the statement just made that the diaphragm is affected on the same side of the body as the operation wound. It does not cover the case of unilateral collapse after median exploratory incisions, and it is contradicted by the occurrence of " crossed " collapse, as when the right lower lobe is affected after radical cure of a left inguinal hernia, or the left base collapses after removal of the appendix or of the right lobe of the thyroid. The following considerations suggest that these exceptions may be more apparent than real. The thyroid, intestines and appendix are, developmentally, median structures; the terminal nerve ramifications on either side probably cross the middle line of the body, and in exploratory operations the surgeon does not usually limit his investigations to one-half of the abdomen.

It must not, however, be supposed that massive collapse occurs only as a post-operative complication, or that it is only met with in surgical practice. I have notes of three cases in which it followed severe bruising of the trunk, without fracture of ribs or ascertainable injury of internal organs: after falls from a horse, from a bicycle, and down a flight of steps. In medical practice it has been met with (post mortem); twice in apical pneumonia, affecting the lower lobe on the same side; and once in a case of portal pyæmia, with dry pleurisy on the affected side. Other instances could be cited.

Massive collapse usually occurs within two or three days of operation, and is relatively uncommon after the fourth day. In uncomplicated cases, the symptoms usually subside rapidly. Dyspnœa rarely lasts more than a few hours, and by the end of twenty-four hours all urgent symptoms have generally cleared up. The displaced heart has already begun to move back towards its normal position, though this may not be fully regained for several days. It must be remembered, however, that collapsed lung is unduly liable to inflammation; and where infective material is at hand, the clinical picture of massive collapse may insensibly give place to that of broncho-pneumonia. It is at present impossible to say what is the relative frequency of post-operative lobar pneumonia and massive collapse, or how many cases of post-operative pneumonia begin as massive collapse. No reliable data can be forthcoming on this point until the exact position of the apex-beat and the condition of the bases of the lungs are carefully and regularly noted before all abdominal operations, and the condition of the chest carefully observed for several days afterwards.

One other point requires notice, namely, the wide differences in the clinical features presented by these cases. It cannot well be a question of degree of collapse only, for in nearly every instance the signs indicate a profound alteration in the physical condition of the lung. It more probably depends on the rapidity and suddenness with which collapse occurs, and on the ability of the heart and sound lung to adapt themselves quickly to the altered conditions of respiration and circulation: the latent cases have occurred chiefly in children and healthy young adults. That the degree of collapse is not altogether immaterial may be inferred from the fact that, in the most acute cases of all, the breath sounds

are almost or quite inaudible over the affected lobe, whereas tubular breathing is usually best heard in cases of the latent type, in which symptoms may be entirely wanting.

Diagnosis and Treatment.—The chief diagnostic signs have already been touched upon. Among the most important are the period of onset, generally within four days after operation, rarely later than the fifth ; the absolute suddenness of onset in most cases, and the displacement of the heart towards the affected lung. The rapidity with which this takes place is remarkable : it is rarely absent at the time of the first examination. The compensatory over-action of the healthy lung sometimes gives the clue to what has happened : it is a confirmatory sign of much value, especially in acute cases.

The occurrence of cough, with free expectoration of greenish mucoid or muco-purulent material, is a very constant symptom, especially among adults. It makes its appearance within an hour or two of onset, too soon to be the result of inflammatory changes within the lung. In cases uncomplicated by bronchitis it usually begins to subside within ten or twelve hours, as re-expansion of the lung proceeds. If secondary inflammatory changes supervene cough continues and the characters of the sputum may become modified. The expectoration in massive collapse is never blood-stained.

The diagnosis from pulmonary embolism—which may be closely simulated by the initial symptoms—rests mainly on the displacement of the heart and the absence of blood in the sputum.

Pneumothorax may be suggested, in right-sided collapse, by the hyper-resonance over the healthy lung associated with disappearance of the heart dullness. Here the true nature of the lesion will be revealed, on auscultation, by the presence of exaggerated breathing.

It is often very difficult to diagnose massive collapse with certainty after the lapse of forty-eight hours, especially if signs of bronchitis are present. And it must be borne in mind that bronchitis and broncho-pneumonia are liable to arise in a collapsed lung if infective material is at hand. In a doubtful case the course of the temperature may give useful information. In such a case the chart shows the initial steep rise to 102 or 103, which usually accompanies collapse, followed after eight to twelve hours—sometimes sooner—by a more gradual fall towards normal. The re-appearance of fever, after a short apyrexial period, generally indicates the onset of inflammatory changes in the lung or small bronchi.

As regards latent post-operative collapse, a slight sudden rise of temperature may be the only indication of its occurrence, and unless the backs are examined daily it is very liable to be missed altogether, unless inflammation follows. There can be no doubt that these cases, with their marked physical signs of consolidation, have hitherto been regarded as instances of post-operative lobar pneumonia, a complication which I believe to be of great rarity. Too much stress cannot be laid on the importance of making a careful examination of the lungs and heart before operation, noting exactly the position of the apex-beat. It is only by so doing, and by closely watching the heart and lungs for the first few days after operation, that one is enabled to appreciate the slight changes in breathing, respiratory movements and position of the apex-beat which herald the approach of trouble.

In the treatment of post-operative collapse of the lung, it must be borne in mind that the acute symptoms are of comparatively short duration, and that the majority of cases end in complete recovery. This only emphasizes the importance of accuracy of diagnosis, in the interest of the patient and surgeon alike.

The symptoms requiring treatment are dyspnœa and general collapse. Dyspnœa, which may be very urgent, is always accompanied by more or less cyanosis. The patient should be propped up by pillows into the sitting posture, and oxygen inhalation started without delay. It should be given at short intervals for a few minutes at a time. In very severe cases it may be necessary to give it continuously for the first hour or two. It usually affords immediate relief. If the patient is collapsed, a hypodermic injection of strychnine is indicated, and in cases where the frequency and smallness, or irregularity, of the pulse show that the heart is severely taxed, a dose of alcohol is often of great benefit. It is not unreasonable to enquire whether, after operation, anything can be done to diminish the liability to collapse. Until we know more definitely what collapse is due to, no satisfactory answer can be given. There is, however, some ground for supposing that any measures which have for their object the maintenance of expansion and respiratory activity of the bases of the lungs are likely to counteract such a tendency. With this object, patients, especially those who manifest signs of weak breathing at the bases, should be encouraged to maintain expansion by such simple means as slow, long-drawn inspirations, at intervals, even at the cost of some discomfort.

Dr. L. A. Dingley and Dr. T. R. Elliott, F.R.S., have in the press a paper based on eleven cases of post-operative collapse observed by them at University College Hospital. I much regret that this interesting communication has come to my knowledge too late to be dealt with in the present article. The authors incline to the view that the collapse is due to obstruction of the bronchioles of the affected lobe by the viscid secretion—with subsequent absorption of the retained air—and that it is not the result of the action of a deflating force, which, as they point out very properly, is assumed in the hypothesis I have advanced. There are, however, in my opinion, serious clinical difficulties in the way of their view of the mechanism of collapse, whilst mine admittedly rests on the action of a force which is, in large measure, hypothetical. My own belief is that, in the present incomplete state of our knowledge of the circumstances which surround massive collapse, a final pronouncement is hardly possible. It may well be that there are other necessary factors, possibly within the lung itself, of which we at present know nothing definite. But careful consideration of all the available data leads me to adhere to the opinion, already expressed, that the mechanism of massive collapse differs from that of lobular or patchy collapse of the lungs.

In conclusion, I append brief descriptions of a few cases of post-operative collapse, together with some tables dealing with post-operative complications, which are of interest in connection with the subject.

Case 3.—**Acute massive collapse simulating pulmonary embolism.**

A healthy man, aged 23. Radical cure for left inguinal hernia on Nov. 9. Case remained aseptic throughout. Anæsthetic : gas, ether, and chloroform : induction normal. Twenty-four hours after operation, without warning of any kind, he was seized

with intense dyspnœa, accompanied by pain across the lower part of the chest. When I saw him, three hours after the onset, he was propped up in bed, with extreme dyspnœa. The face was dusky, the expression anxious, and the alæ nasi working strongly. Pulse 132, regular. Temperature above 102°. Chest: The whole of the left front and axilla were hyper-resonant, and the heart dullness was obliterated. The heart-beat was in the fourth right interspace, close to the sternal border. There was loud exaggerated breathing all over the left front, without adventitious sounds. On the right side, resonance was just normal in the first space, and below this, increasing dullness right down to the base. Upper level of liver dullness slightly raised. Breathing weak over right front, inaudible at the base. Vocal fremitus much diminished on right side. Epigastric movement normal. Temperature rose that evening to 103°. Next morning (twelve hours after the onset) the patient was much better. Cyanosis had almost disappeared, and there was only slight dyspnœa. Temperature 99°, pulse 84. On the third day the apex-beat was just to the left of the sternum, and the right lung recovering rapidly. The position of the apex-beat did not become normal for a fortnight.

Case 4.—**Acute collapse of left base on third day after salpingectomy.**

A married woman, aged 24, of unusually fine physique. A left pyosalpinx was removed on April 5. The temperature began to rise gradually on the same day. On the 8th she complained of pain behind the lower end of the sternum and between the shoulders. Respirations 24. The breathing was weak over the left base. At 2.0 p.m. she was suddenly seized with alarming dyspnœa and cyanosis. Temperature 103°; pulse 120; respirations 40. The patient looked desperately ill. She was sweating freely and felt cold, but there was no rigor. The apex beat could not be located. Nothing abnormal was detected on pelvic examination. There was marked dullness over the left lower lobe. Vocal fremitus diminished, vocal resonance increased, with a slight nasal quality. Breathing almost inaudible. No crepitations. At 10.0 p.m. temperature was 104·8°; pulse 132; respirations 45. The heart's apex was located far out in the left axilla. A few crepitations were now heard at the left base. The right lung was hyper-resonant. At 2.0 a.m. on the 9th, the temperature had fallen to 101·8°; pulse to 122; respirations to 40; all the symptoms were diminishing in severity. At 10.0 a.m. the temperature was 98·8°; pulse 120; respirations 24; dullness at the left base had diminished both in extent and degree, and the apex-beat had moved back nearer to the normal position. There was free expectoration of muco-purulent sputum, which yielded a scanty growth of pneumococcus. Four days later the physical signs had almost disappeared, but the girth of the left chest was still 1 in. less than the right.

Case 5.—**Massive collapse simulating pneumonia.**

A small delicate woman, with uterine fibroids. She had suffered from bronchitis for several months. On admission the apex-beat could not be located, but the superficial cardiac dullness was normal. There were some sibilant rhonchi over the backs, but no trouble at the bases. Subtotal hysterectomy was performed on Feb. 15. Chloroform well taken. She was comfortable and free from lung symptoms next day. Early on the 17th she had an attack of pain in the right chest, and her breathing became short and frequent. On examination, there was dullness and tubular breathing all over the right lower lobe, with almost total loss of vocal fremitus. Percussion was impaired over the upper and middle lobes, and the right chest moved badly. The girth at the level of the fourth rib was 12·2 in. on the right, as against 13·5 in. on the left side. Heart's apex-beat in right fourth space, 1 in. from the sternum. Temperature rose to 102·6°; pulse to 120; respirations between 26 and 32. Rhonchi were heard over both backs, but no crepitations. These symptoms persisted for four days, and then rapidly subsided. The apex-beat regained its normal position on the third day. Within twenty-four hours of onset the patient began to expectorate viscid greyish-green sputum, which yielded pneumococci and streptococci.

It is quite possible that this patient had a very slight attack of broncho-pneumonia; but the initial lesion was clearly massive collapse of the right base.

Case 6.—**Massive collapse on fourth day after cholecystectomy.**

A married woman of good physique, aged 45. Cholecystectomy was performed on June 10. Anæsthetic: gas, ether, and chloroform; taken well. Drainage tube removed on the 12th. Next day the temperature had risen to 100·4°. Some mucus in trachea. Respirations 30, but no abnormal signs over fronts. On the 14th, after a fair night, the patient suddenly turned rather blue, and there was an appreciable increase of dyspnœa. Respirations 40; pulse 120, rather thready. Chest examined at 11.30. Apex beat not discoverable. Left chest hyper-resonant, the note extending a finger's breadth beyond the right sternal margin opposite the lower end of the sternum. Increased movement of left chest, with loud exaggerated breathing. Right front resonant to fourth rib, dull below this level and behind, below the scapular angle. Weak tubular breathing over dull area after cough, otherwise silence. No moist sounds. Superficial heart dullness obliterated. Impulse not felt, but sounds most distinctly heard in right fourth space 1 in. internal to the nipple. The symptoms, which were never urgent, subsided on the second day, the physical signs clearing up rather more gradually.

Case 7.—**Latent collapse after removal of appendix.**

A healthy-looking boy, aged 12. The appendix was removed on a Wednesday afternoon. Before operation the heart was normal, but there was weak breathing at the right base, with very slight impairment on percussion, a not very unusual event in these cases. Anæsthesia was induced with gas and ether, but chloroform was substituted within three minutes on account of hypersecretion.

The boy was very little upset by the operation, and was remarkably well and cheerful next morning. The temperature rose to 100° that evening, but was normal again on Friday morning, when the house surgeon discovered signs of collapse on his morning round. I examined the chest the same afternoon. The child looked quite happy, and did not exhibit the slightest sign of discomfort. The right chest was hardly moving at all, the left was over-acting. The superficial cardiac dullness was almost gone. The apex beat was felt on the right of the sternum behind the third and fourth rib cartilages, where the heart-sounds were also loudest. Percussion was a trifle flat over the right upper lobe, becoming gradually more impaired towards the base, which was quite dull. Breathing was very weak all over the right chest, and distinctly tubular behind, over the lower lobe. On the left side the breath-sounds were exaggerated. No râles were audible. Beyond a very occasional short cough, there was absolutely nothing to suggest lung trouble. Next day the boy was as well as ever. Apex-beat at left edge of sternum; signs otherwise unchanged. Two days after this the chest was perfectly normal.

Case 8.—**Latent "crossed" collapse after removal of appendix.**

A single woman of good physique, aged 23. Operated on the day of admission for acute appendix trouble. Heart and lungs normal before operation, with the exception of slightly weaker breathing at left base behind. Some turbid fluid in peritoneum. Quite comfortable next day. Temperature began to rise at 6.0 a.m. on the second morning after operation. Pulse rose from 104 to 130; respirations from 24 to 30. Patient was rather flushed, but experienced no pain or discomfort of any sort. On the third morning, the condition of the abdomen being satisfactory, the house surgeon examined the chest in the hope of being able to account for the fever. He found dullness over the left chest. I made the following note that afternoon: "Left side dull up to the clavicle. Abdominal note rises higher than usual, reaching the fifth space in left mid-axillary line. Percussion rather skodaic in first two spaces, but the condition does not suggest effusion. Vocal fremitus increased. Breath-sounds quite distinct and broncho-tubular. No râles. Apex-beat displaced outwards to fifth space in left mid-axillary line. Movements of left chest much impaired; girth 1 in. less than right. Right lung healthy, not appreciably hyper-resonant, but reaching to left edge of sternum." Temperature began to fall on the third afternoon, reaching normal next day. Simultaneously the left lung began to re-expand and the heart to travel inwards, the normal position being reached on the seventh day. Chest normal after fifth day.

I am much indebted to Mr. B. Sangster Simmonds, one of my late house physicians, for carrying out a very careful analysis of the records of 3559 laparotomies and renal operations performed at the Middlesex Hospital during the five years, 1906–10, of which the results are set out in the following tables—

DISTRIBUTION OF LUNG COMPLICATIONS IN 3559 ABDOMINAL OPERATIONS PERFORMED AT THE MIDDLESEX HOSPITAL DURING THE FIVE YEARS, 1906–1910.

Site of Operation	No. of Cases	No. of Lung Complications	Percentage
Stomach	253	34	13·4
Liver and gall-bladder ..	109	13	11·9
Intestines	175	6	3·4
Appendix	805	29	3·6
Kidneys	161	8	4·9
Pelvic organs	924	62	6·7
Hernia	882	32	3·6
Bladder	53	1	1·8
Exploratory operations ..	167	14	8·3
Miscellaneous	30	2	6·6
Totals ..	3559	201	5·6

The frequency and fatality of the several complications are as follows :—

Complication	No. of Cases	No. of Deaths
Pneumonia	88	31
Bronchitis	53	4
Dry pleurisy	26	0
Massive collapse	12	1
Pleural effusion	7	1
Pulmonary embolism or infarct ..	8	4
Gangrene of lung	2	2
Abscess of lung (?)	1	0
Empyema	4	2
Total ..	201	45

The only death in the massive-collapse group was due to general sepsis.

Mr. Simmonds considers, from the descriptions given in the notes, that 20 cases recorded as pneumonia were probably examples of massive collapse; this would give us 68 cases of pneumonia and 32 of massive collapse.

The relation of the condition of the wound to the incidence of complications was as follows :—

Condition of Wound	No. of Cases	Complications	Percentage
Clean	2698	134	4·79
Septic	861	67	7·78

The influence of the site of operation on the frequency of after-effects is shown in the subjoined table :—

Site of Operation	No. of Cases	Complications	Percentage
Above umbilicus.. ..	405	51	12·59
Below umbilicus ..	2993	142	4·74
Operations on kidney ..	161	8	4·9

The following facts were elicited as to the day of onset of lung complications :

Day of Onset	1st	2nd	3rd	4th	5th	6th	7th	After 7th
No. of cases	46	35	14	16	7	11	8	54

The great majority of the complications developing more than a week after operation were due to pleurisy, septic bronchopneumonia, empyema, and embolism. Besides the above, there were ten cases of doubtful date. In most of these the lung lesions were discovered post mortem.

The relation of the anæsthetic to the incidence of lung complications is shown in the following table :—

Anæsthetic	No. of Cases	No. of Complications	Percentage
Gas, ether, chloroform ..	2489	129	5·18
Chloroform	452	35	7·74
Gas, ether	475	25	5·26
Chloroform, ether ..	133	3	2·25
Ether	2	1	—
Doubtful	8	8	—

The relation of the various complications to the anæsthetic employed was as follows :—

Complication	No.	G.E.C.	C.	G E.	C.E.	E.	Doubtful
Pneumonia	88	54	15	14	1	1	3
Massive collapse ..	12	8	1	2	1	—	—
Bronchitis	53	32	14	4	1	—	2
Pleurisy	26	22	1	3	—	—	—
Pleural effusion ..	7	5	—	—	—	—	2
Embolism	8	5	2	1	—	—	—
Empyema	4	2	1	1	—	—	—
Gangrene of lung ..	2	1	1	—	—	—	—
? Abscess	1	—	—	—	—	—	1

By the kindness of Mr. T. Lionel Hardy I am enabled to supplement the above tables with some figures relating to the abdominal and renal operations performed at the Middlesex Hospital during the years 1911, 1912.

In some 2000 cases there were 65 instances of post-operative lung trouble; rather over 3 per cent, as compared with 5·6 per cent in the earlier series. Of the 65 lung complications, 19 were cases of pneumonia—of which, at most 2 may have been lobar—and 16 were examples of massive collapse. To these should be added two or three cases diagnosed as pulmonary embolism, which Mr. Hardy is satisfied, from the descriptions given and the absence of blood-stained sputa, were in reality cases of collapse. These figures furnish an interesting contrast to the 32 cases of collapse against 68 of pneumonia, estimated by Mr. Simmonds in the previous tables.

The distribution of the cases of massive collapse shown in the subjoined table is very instructive, and it is also worthy of note that in this series there were no instances of crossed collapse or of collapse after an exploratory operation.

It will be observed that 14 out of the 16 cases were associated with operations on the lower part of the abdominal cavity, and only two with operations above the umbilicus; a curious contrast with the table showing the influence of the site of operation on the frequency of after-effects generally, suggesting that massive collapse stands in a category of its own, and lending strong support to the view that it is of reflex origin.

INCIDENCE OF MASSIVE COLLAPSE AFTER ABDOMINAL OPERATIONS AT THE MIDDLESEX HOSPITAL IN 1911 and 1912.

Site of Operation	Total Number of Cases	Cases of Massive Collapse
Stomach	97	1
Liver and gall-bladder ..	56	1
Intestines	105	0
Appendix	692	7
Kidney	62	0
Pelvic organs	373	7
Hernia	397	0
Bladder	35	0
Exploratory	113	0

REFERENCES.

[1] *Internat. Jour. Med. Sci.* 1890, Sept.
[2] *Trans. Med. Soc.* vol. 34.
[3] The Bradshaw Lecture for 1908, Royal College of Physicians.

TYPHOID SPINE: A REPORT OF TWO CASES, AND A SHORT REVIEW OF THE SUBJECT.

By S. J. ELKIN and JASPER HALPENNY, Winnipeg.

Case 1.

James Dann, aged 17, teamster, with good family history, having no discoverable record of tuberculosis, was taken ill on July 11, 1912, with pain and tenderness in the right iliac region, elevated temperature, and quickened pulse. Blood examination on July 14 gave Widal negative and leucocyte count 6500. Examination again on July 15 gave Widal doubtful, though the blood of that date showed the presence of the typhoid bacillus. Examination on July 19 gave a positive Widal. The disease ran a moderately severe course. The right ear discharged pus from August 20 for about ten days.

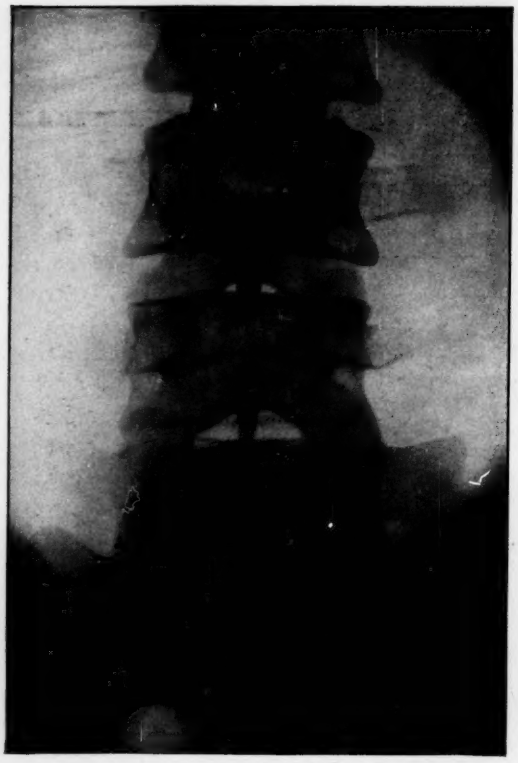


Fig. 387. *Case* 1. Radiogram taken Sept. 12, 1912. Shows no changes in the vertebræ.

On August 31, or about seven weeks from the onset of the symptoms, the patient first complained of pain in the left lumbar region, back towards the spine. Heat and liniments were applied for a few days, with little relief. He thought the hot-water bag lessened the pain somewhat, and gentle rubbing seemed to benefit the pain considerably. On September 7, the pain became so severe, particularly at night, that morphine had to be resorted to and was given every night for about a week. On September 11, a von Pirquet test was made which proved to be negative. On September 12, a leucocyte count showed 7200, and the temperature ranged from 99° to 100°. On the same day a radiograph was taken of the lumbar region, which did not show any changes in the vertebræ (*Fig.* 387).

At this time there was extreme tenderness in the left lumbar region. The points of greatest tenderness were the tips of the transverse processes of the

2nd, 3rd, and, 4th lumbar vertebræ on the left side. Patient complained of pain in his right knee at the same time, and hot-water bottles were applied to it for some days.

On September 21, a plaster-cast was applied that included the lower part of the chest and upper part of the pelvic bones. Patient was very thin, and did not experience the relief that we expected, and the cast had to be removed on September 30.

From August 31, when the pain first appeared in the spine, until September 24, when patient left the hospital, the temperature ranged from 99° to 100°, except for five days: September 11 to September 15, on which days it reached 103·4°, 101·2°, 101·8°, 102·2°, and 101·4°. The urine showed traces of albumin from July 16 to July 23, but none was present after that date.

From September 24, when the patient went home, till November 9, he was kept at rest in bed. After the cast was removed on September 30, a felt jacket was adjusted to his spine, but this he was also unable to wear while in bed. Thus, rest in the prone position was the major part of the treatment. Early in October he required morphine a few nights for the pain, but this was soon dispensed with. After November 9 he was allowed out of bed, at first for only half an hour each day. For a time he wore the felt jacket while sitting up, and it gave him some relief from pain caused by movement. By Christmas all pain had ceased.

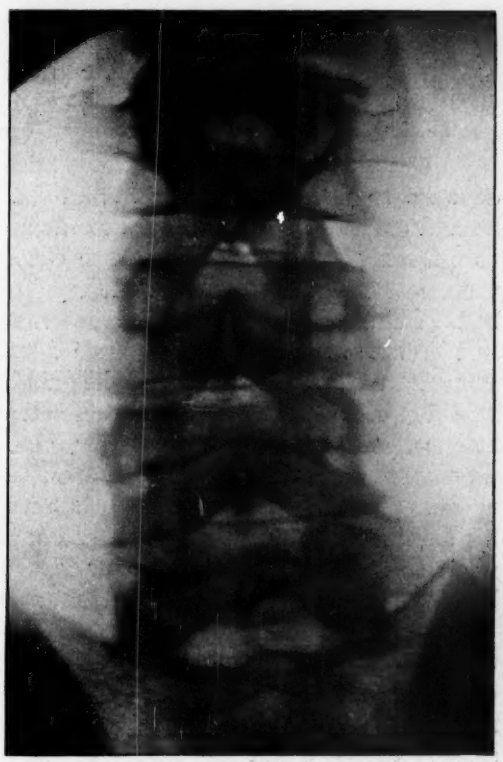


FIG. 388. *Case* 1. Radiogram taken Dec. 21. Shows distinct changes in the 3rd, 4th, and 5th lumbar vertebræ. On the right side of these vertebræ the bodies are compressed, and from their margins is seen an irregular bone outgrowth.

On December 21, a second radiographic plate was taken, which showed distinct changes in the 3rd, 4th, and 5th lumbar vertebræ (*Fig.* 388). On perpendicular measurement these three vertebræ showed about half an inch less than the same three vertebræ in the plate taken three months previously, and new formation of bone was evident at the sides of the vertebræ. There was then distinct kyphosis in the lumbar region.

Patient now feels in his usual health and weighs about 146 lb. His weight before entering the hospital was 150 lb., and when he was first able to go outside of the house it was 105 lb. His back gets stiff if he sits for any length of time in one position. He can walk as far as he pleases without any inconvenience,

but cannot skip or bring both legs from the ground at the same time. He has tried work with a hay-fork, and found he could work with his back straight, or when flexing and straightening his back, but could not work and keep his back bent all the time—as in picking potatoes. He complains of a numbness on the outer side of the left thigh in the course of the lateral cutaneous nerve, and also of a weakness in his right knee, as though his leg might give way under him without warning. His knee-jerks are equal and normal. His spine shows marked kyphosis—curved, not angular—in the lower lumbar region, and movement of these vertebræ is somewhat limited.

CASE 2.

E. Doherty, male, aged 27, admitted to the Winnipeg General Hospital, July 1, and discharged October 21, 1912. Up to March the patient was always strong and healthy. Early in March he was taken ill, and on the tenth of the month was removed to a hospital with a diagnosis of typhoid fever. In a few days he became delirious, and remained so for three weeks. During this time he had erysipelas also. The temperature chart for this time is not available to us. During April the temperature came down to normal. While in bed there were no complications except the erysipelas. On May 1, he was allowed out of bed. Pain now came on for the first time. It was in the right side of the back, and became so severe that in three days he was compelled to go to bed again. Fomentations were applied, and the pain became easier, though it had not entirely subsided when he was allowed out of bed at the end of three weeks. He remained in the hospital three weeks longer, but was not confined to bed. Pain was present all the while, and also when he left the hospital. It got steadily worse. He did not remain quiet, but walked about the streets. At the time of his admission to the Winnipeg General Hospital he was suffering severely. At night sudden spasms would occur in the right leg, accompanied by flexion at both the hip and the knee. Physical examination was not recorded for some time after admission. When first seen by us, the knee-jerks were normal, and there was no tenderness, redness, or swelling over the spine, though tapping along the spine caused pain. All movements of the spine caused excessive pain. Any attempt at sitting up in bed also caused severe pain. There were no other sensory changes, and no atrophy of the muscles. There was no kyphosis, but a slight decrease in the normal lordosis was observed. Between July 1 and July 25, when first seen by us, the nurse's bedside notes recorded the fact that the patient slept badly and suffered from pain, chiefly at night. A review of the notes regarding about twenty-five ward patients showed that this patient suffered more pain and slept less than any patient in the ward. Some nights the hot-water bottle was used; other nights a mustard plaster was applied. The temperature was very erratic, on one occasion reaching 103°, and several times 102°. After July 13 it remained normal. On July 25 an *x*-ray was taken (*Fig.* 389). Here a commencing new formation of bone is seen laterally between the 1st and 2nd lumbar vertebræ, and a marked disappearance of the intervertebral disc. Three days later a plaster cast was put on. That night the nurse's report stated that the patient felt comfortable, and the following night the only note was that the patient slept well. Yet every night up to the time the cast was applied, notes

like the following were recorded: "Wakeful at intervals, with pain." "Back painful, mustard plaster applied." "Bad night, pain in hips." On only four occasions was any note recorded of pain in the back after the cast was put on. He was kept in bed till October 14, and on October 21 was discharged with a light cast on. This was removed a little later. There was then no pain or tenderness, though there was still marked limitation of motion. Just prior to leaving, a second *x*-ray was taken. This showed an extension of the new formation of bone noted in the former plate. There was also seen a more decided loss in the substance of the intervertebral disc.

The patient was able to commence work early in 1913, though the back still felt stiff. The chief difficulty then lay in the loss of flexion of the lower spine.

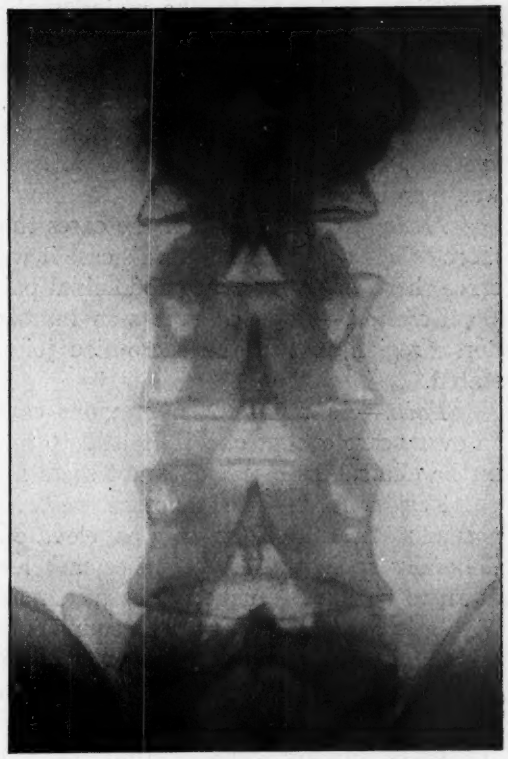


FIG. 389. *Case 2.* Radiogram taken July 25, 1912. A commencing new formation of bone is seen laterally between the 1st and 2nd lumbar vertebræ, and a marked disappearance of the intervertebral disc.

These two cases are cited to draw attention again to this somewhat rare sequela of typhoid fever. Its early recognition, with rest in bed, and probably support to the spine, would do much toward saving the patients from great suffering, and also from some of the permanent disability formerly seen in these cases.

The *x*-ray findings here are quite sufficient evidence to disprove the contention that these cases are pure neuroses, and though similar spinal conditions due to other causes are seen, the name "typhoid spine" seems appropriate. When the typhoid bacillus is the cause, assurance can be given the patient that the pain will cease, never to return, and that the only permanent damage is immobility of the spine. Furthermore, in the light of available histories, considerable assurance can be given that life will not be shortened.

In 1909, one of us[16] reviewed 72 cases of typhoid spine reported in the literature up to December, 1908. To this we are able to add 20 cases reported since that time. These, with the 2 here added, make 94 in all.

A study of the cases since 1908 reveals the fact that when treatment is commenced early, spinal deformity rarely occurs, convalescence is short, and recovery is nearly complete,—that is, the movements of the spine approach

more nearly to the normal. A review of the details may be of interest; it refers to 20 cases from the literature and the 2 cases here reported, or 22 in all.

Age.—The age is mentioned in all cases but one. 8 are under twenty, the youngest being ten years old.

Sex.—All males except 2.

Original Fever.—There seems to be no more likelihood of the condition occurring in severe cases than in milder ones. In 5 the disease was mild, in 7 moderate, and in 7 severe.

Time of Onset.—In the majority the pain came on during convalescence. In Wilson's case a little pain occurred during convalescence; it then cleared up, but in five months became so severe that treatment was necessary.

Cause of Onset.—In White's[25] case, a boy, aged 16, took a hard ride on a bicycle, which was followed by an acute onset. In one of Frick's[11] cases, a boy, aged 18, was exposed to cold and wet. In the majority no direct cause of onset was mentioned.

Mode of Onset.—In half the cases the onset was gradual, and in half it was more or less acute. In Wilson's case it was particularly acute. In one of Frick's cases there was very acute abdominal pain at first.

Location.—In 14 cases it was lumbar, in 5 dorso-lumbar, in 1 in the lower dorsal region, in 1 in the sacro-iliac joint, and in 1 case the location was not stated.

Pain.—As reported in previous cases, the prominent symptom was pain. In every case except one it is said to have been severe. From the uniformity in the clinical history it does not seem likely that these cases are pure neuroses.

Temperature.—The temperature was reported in 17 cases. In 1 it was normal; in all others it was elevated. The highest reported was 103·4°. Generally speaking, the pain becomes less at the time the temperature comes down to normal. Auclair,[2] however, mentions that this did not occur.

Leucocytes.—The leucocyte count is mentioned in only 5 cases. In 2 it was taken twice. The highest count was in Frick's first case, being 17,400. It would seem desirable that a count should be taken frequently in all cases reported hereafter.

Local Signs.—Swelling over the affected vertebræ is reported only 3 times, and in 2 it is stated to have been absent. Tenderness is, however, the rule, being definitely mentioned 12 times.

Sensory Disturbances.—These vary widely. In Ardin-Delteil's[1] case there was tenderness along the sciatic nerve, hyperæsthesia of the sacro-lumbar region, and loss of sensation on the inside of the left hip and leg. In Auclair's first case there was a region of hyperæsthesia from the last rib to the inguinal fold; and in his second case, a similar, though more extensive, hyperæsthesia was present. In Brownlee's[6] case there was disturbance of heat-sensation and loss of pain-sensation up to the lower costal margin. At the end of twenty-one months these sensations were still delayed in the feet and the lower third of the legs.

Reflexes.—The patellar tendon-reflex was diminished in 2 cases, increased in 9, normal in 1, and in the other cases no mention is made. Babinsky's sign was present in 1, and ankle-clonus in 4 instances.

Muscles.—In only 2 cases is there stated to have been atrophy of the muscles in the legs, which was probably due to interference with the nutrition through

the nerve-supply. During the acute stage, rigidity of the abdominal muscles is mentioned 4 times. Goddu[14] says these muscles were hard and board-like. In Frick's case, there were rhythmical contractions of the abdominal muscles synchronous with the pulse—absent during sleep; they kept on for a week. Later on there was marked rigidity of the right rectus abdominis, lasting for four days.

Spinal Deformity.—In 1 case there was lordosis, in 3 scoliosis, in 1 kyphosis, and in 2 the spine was unduly straight. In 4 cases it is definitely stated that there was no spinal deformity. In the rest no mention is made of this feature.

X-ray Report.—Here there is much more information than formerly. In the 72 cases previously reported, only 11 had been *x*-rayed. An *x*-ray was taken in 14 cases in this series. 1 refused examination; in 2 nothing was revealed. In Siredey's case there was thickening on the left side of the vertebral column opposite the second, third, and fourth lumbar vertebræ. In the other cases there were changes noted in the intervertebral discs. Goddu says there were many changes in the last dorsal and first lumbar vertebræ. Swett says the disc between the fourth and fifth lumbar vertebræ had disappeared, and that there was evidence of new bone-formation. McIntyre[15] says of his first case, "Between the fourth and fifth lumbar vertebræ it will be observed that the intervertebral disc is somewhat thickened. On the right, one sees a considerable deposit of bone extending from the spine to the crest of the ilium." In his second case there was considerably increased density in the fourth intervertebral disc. The increasing evidence obtained by skiagrams helps materially to dispose of the question whether some of these cases were pure neuroses. Carling and King[7] report, in their case, "a dense shadow over the bodies of the ninth, tenth, and eleventh dorsal vertebræ, extending laterally beyond their limits and expanding from above downwards to a point an inch outside the articular process on the right side, and further on the left." Another skiagram taken three weeks later showed the mass to be less dense, while the costo-vertebral articulations could now be made out. They say very little bone-formation resulted, and interpreted the mass to be an "effusion beneath the periosteum, or the anterior and lateral ligaments, and around the costal joints."

Caries.—In Fried's case, "gibbus" developed in the region of the twelfth dorsal to the third lumbar vertebræ. This is only the second case out of 94 in which bare bone is definitely said to have occurred.

Treatment.—The treatment has consisted of rest in bed and mechanical support—plaster of Paris, adhesive strips, or a steel brace.

Result.—Here lies probably the greatest difference between this condition and tuberculous disease of the spine. All these cases made an almost complete recovery. The longest time before symptoms disappeared was in Brownlee's case, where they lasted over twenty-one months. Auclair states that the scoliosis, which was present during the acute stage, disappeared. One striking point is illustrated by White's case, where mention is made of the immediate relief which occurs when the back is put at rest by the application of a plaster-of-Paris jacket.

Auclair performed a lumbar puncture in his two cases, and found marked hypertension in one, the other being normal.

Ellis[8] undertook to study experimentally joint-affections induced by the typhoid bacillus. He injected the bacillus into the blood and also into the joints of rabbits. The attempts to localize the affections in the joints by trauma, or interference with the circulation, were negative. When the bacilli were injected into the joints it was demonstrated that " the typhoid bacillus is capable of seriously damaging and even destroying the various elements entering into the formation of the joints. Collectively, all the component parts of those structures—synovial membrane, interarticular ligaments, semilunar cartilages, articular cartilages, bone, the joint capsule—and the surrounding tissues, including the muscles, were thus affected." It must be kept in mind, however, that infection in the human subject seems quite unlikely, from clinical reports, to cause necrosis of bone in the spine, but does so frequently in other locations. Baron's[3] paper well illustrates a fact commonly known in regions where typhoid is common. In his case, a female, aged 28, there were fluctuating tumours in the right mastoid, both tibial diaphyses and the upper and inner left fore-arm, which came on a few days after the temperature became normal. These were all opened, and thick pus and bony fragments were discharged from the cubital abscess. Bacteriological examination showed pure cultures of the typhoid bacillus. All were healed in a couple of weeks.

Laignel-Lavastine[18] cites a case of a female, aged 50, who, two months after recovery, had seven subperiosteal abscesses—on the left tibia, right tibia, left cubitus, right femur (two), left femur, and the lower part of the sternum. It was five years before the last of the seven healed, and then after the discharge of a piece of necrosed bone. Necrosis of the ribs is a matter of fairly common experience where typhoid is prevalent. Quincke and Stuhlen[21] found the *B. typhosus* in the ribs in 8 cases out of 9 examined post mortem. Fraenkel[10] found it present in the vertebræ in all of the 10 cases examined. Why necrosis is so rare in the vertebræ, while it is fairly common in other bones, is not clear.

We wish, in closing, to express the view that the condition known as " typhoid spine " should be admitted as a definite clinical condition. Fortunately, its onset is usually heralded by much pain. If warning is taken and the spine is put in a position of perfect rest the prognosis is exceedingly good: it is not so favourable, however, when some other cause exists.

REFERENCES.

[1] ARDIN-DELTEIL, RAYNAUD, and COUDRAY, Spondylite Typhique. *Rev. internat. d. Méd. et d. Chir.* 1912, xxiii, 247.

[2] AUCLAIR, J., and WEISSENBACH, R. J. Deux Cas de Spondylite Typhique Observés à Paris. *Bull. et Mém. Soc. Méd. d. Hôp. d. Paris*, 3d ser., 1912, xxxiv, 353.

[3] BARON, L., and DESCUNS, M., Sur un Cas d'Ostéo-Périostites Eberthiennes Multiples. *Toulouse Méd.*, 2nd ser., 1911, xiii, 152.

[4] BERNERT, *Wien. klin. Rundschau*, 1909, xxiii, 709.

[5] BERRY, W. T., Consideration of the Typhoid Spine. *Trans. Med. Assoc. Alabama*, 1908; also in *Mobile Med. and Surg. Jour.*, 1908, xii, 215.

[6] BROWNLEE, J., Spinal Affections Following Enteric Fever.

[7] CARLING, E. R., and KING, L. R., Case of Typhoid Spine. *Lancet*, 1910, i, 1136.

[8] ELLIS, A. G., Experimental Study of Joint Affections Induced by Typhoid Bacillus. *Proc. Path. Soc. Phil.* new ser., 1909, xii, 179.
[9] ELMER, W. G., Sacro-Iliac Arthritis following Typhoid Fever. *Trans. Acad. Surg. Phil.*, 1912, xiv, 23.
[10] FRAENKEL, E., Ueber Erkrankungen des roten Kmochenmarks besonders der Wirble bei abdominal typhus. *Mitteil. aus den grenzgeb. der med. u. chirg.*, 1903, xii, 419.
[11] FRICK, A., Spondylitis Typhosa (Three Cases). *Interst. Med. Jour.*, 1910, xvii, 819.
[12] FRIED, Paratyphus mit Spondylitis Typhosus und Rückenmarkskompression. *Deut. Med. Woch.*, 1912, xxxviii, 94.
[13] GIACOMO, *Gaz. d. Osp. Milano*, 1908, xxix, 1512.
[14] GODDU, L. A. O., Typhoid Spine. *Boston Med. and Surg. Jour.*, 1910, clvii, 711.
[15] HALPENNY, J., and MCINTYRE, D. F., Two Cases of Typhoid Spine. *Canad. Med. Assoc. Jour.*, i, No. 2, 136.
[16] HALPENNY, J., Typhoid Spine. *Congrés Internat. de Med.* xvi, also *Surg., Gyn. and Obst.*, 1909, Dec.
[17] LAFORCADE, 1912, Bordeaux.
[18] LAIGNEL-LAVASTINE, Ostéo-Périostites Post-Typhoidiques Suppurées et Plastiques. *Bull. et Mém. Soc. Méd. d. Hôp. d. Paris*, 3rd ser., 1912, xxxiii, 916.
[19] PHILLIPON, 1908, Lyons.
[20] POTTER, N. B., Spondylite Typhique. *Bull. et Mém. Soc. Méd. d. Hôp. d. Paris*, 3rd ser., 1910, xxix, 811.
[21] QUINCKE, H., Ueber Spondylitis typhosa. *Mitteil a. d. grenzgeb. d. Med. u. Chir.* 1898–99, iv, 244.
[22] RUNBERG, *Salsk handl.* 51, 1909, ii, 377.
[23] SIREDEY, M. A., Spondylite Typhoidique. *Bull. et Mém. Soc. Méd. d. Hôp. d. Paris* 3rd ser., 1913, xxxvii, 680.
[24] SWETT, PAUL, Typhoid Spine. *Yale Med. Jour.*, 1909–10, xvi, 117.
[25] WHITE, F. W., Typhoid Spine. *Jour. Amer. Med. Assoc.*, lii, 556.
[26] WILSON. C. J., A Recent Case of Typhoid Spine. *Lancet*, 1909, ii, 1279.

ON THE LATE RESULTS OF THREE CASES OF TRANSPLANTATON OF THE FIBULA: WITH REMARKS ON THE PROCESS OF GROWTH AND THE PHYSIOLOGICAL DEVELOPMENT OF TRANSPLANTED BONE.

By C. J. BOND, Leicester.

Huntingdon was, I think, the first surgeon to publish a case in which a successful attempt had been made to replace the loss of the whole shaft of the tibia by transplanting the shaft of the fibula into its place.[1] Since that time other surgeons have reported similar cases (see Bibliography).

In recording these two additional cases, the first of which was operated on in May, 1905, I wish to draw attention not only to the surgical results, but also, more especially, to certain points concerning the manner of growth and the physiological development of transplanted bone.

CASE I.

B. P., a little girl aged 4 years. The shaft of the right tibia had been destroyed by osteomyelitis in June, 1904. The acuteness of the infection also damaged (as we shall see later) the epiphyseal cartilages, especially the upper one, and interfered with their osteogenetic capacity of providing for the continued growth of the new shaft, especially in length. The disease also affected the fibula in the same leg. A small focus of local necrosis formed in the lower third of this bone, from which spot a sequestrum was removed later. This accounts for the thickened and irregular outline of the shaft of the transplanted fibula as seen in the radiograms at the time of operation (*Fig.* 390).

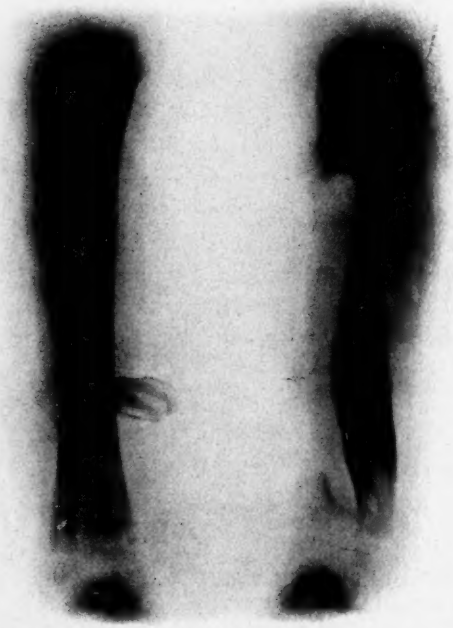


Fig. 390.—B. P. Fibula transplanted at upper end only, 1905. (The figure is reversed.)

In May, 1905, the limb was in a sufficiently sound state to warrant an attempt to supply the place of the necrotic tibia, which had been previously removed. Accordingly, the right fibula was cut across just below the head of the bone, and this portion, with the epiphyseal cartilage, was left in its normal position. The divided

FIG. 391.—B. P. Transplantation of fibula complete, 1907.

FIG. 392.—B. P. Growth of transplanted bone two years later, 1909.

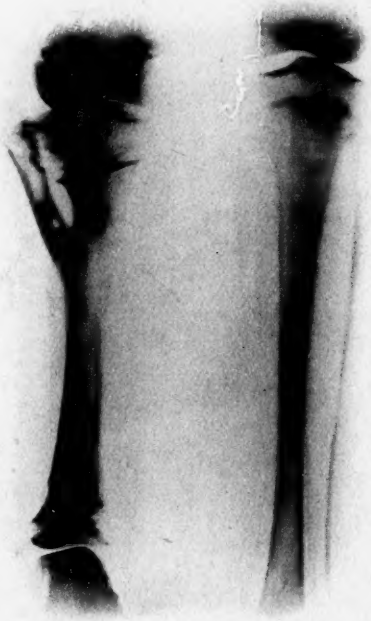


FIG. 393.—B. P. Condition of transplanted bone in 1910.

FIG. 394.—B. P. Condition in 1913. (The figure is reversed.)

end of the shaft of the fibula was then pushed over to the inner side and inserted into the freshened lower surface of the tibial epiphysis, to which it was wired in position. Some difficulty was experienced in keeping the sutured bones in good position, owing to the friability of the softened bony tissues, and to the drag of the muscles, which tended to displace the fibula outwards to its old position. This necessitated a second operation and the introduction of a second wire suture.

FIG. 395.—B. P. Condition in 1914. (The figure is reversed.)

Within the next two months, however, firm bony union had taken place. Skiagrams taken at intervals showed that the upper end of the shaft of the fibula had begun to assume the flattened, inverted-cone-shaped outline characteristic of the normal tibia. Bony outgrowth also took place from the isolated upper fragment of the fibula, and photographs show a column of bone passing outwards from the head of the fibula, connecting it with the shaft in its new position.

Considerable delay occurred in operating upon the lower end of the fibula, owing to the presence of a sinus and the existence of a small area of diseased bone in the lower part of the shaft. This was, however, removed, and the sinus eventually healed.

In March, 1907, the fibula was divided just above the external malleolus, and the lower end of the shaft was displaced inwards and inserted into the soft cancellous tissue of the lower tibial extremity.

Skiagrams (*Figs.* 391, 392, 393, 394, 395) show the gradual thickening of the shaft of the transplanted fibula beginning at the points at which it was embedded in the tibial epiphyses.

They also show the alteration in shape of the transplanted shaft from the year 1907 to the present time.

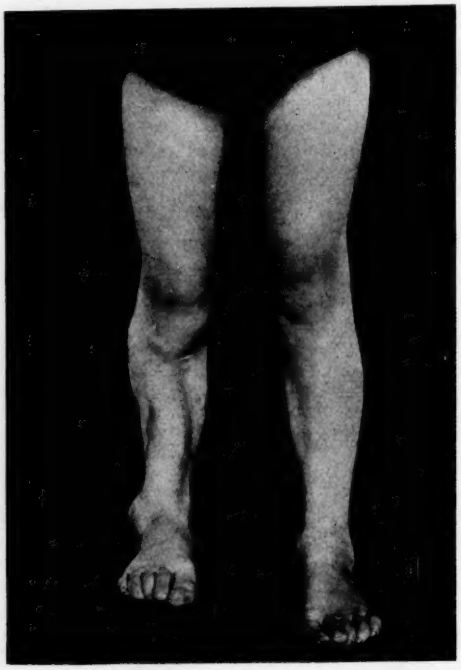


FIG. 396.—B. P. Condition in 1909, four years after operation.

The relatively small amount of bone thrown out from the cut end of the external malleolus is in sharp contrast with the exuberant deposit formed by the head of the fibula.

The child is now 13 years old, and walks and runs, with the aid of a high-soled boot, without any noticeable limp. She goes to school and lives the life of a normal child. The actual shortening of the leg amounts to about three and a half inches. *Fig.* 396 shows the condition of the limb in 1909, four years after operation.

CASE II.

W. P., a boy, in whom the shaft of the right tibia was destroyed by osteomyelitis in 1907. This was removed as a sequestrum in November of that year, when the boy was 10 years old.

FIG. 397.—W. P. Before operation, 1908.

FIG. 398.—W. P. After operation, 1908.

The skiagram (*Fig.* 397) shows the condition of the leg when the boy came into the Leicester Royal Infirmary early in 1908. The place of the lost tibia was supplied by transplanting the shaft of the fibula in two stages, as in the last case.

At the first operation, in March, 1908, the shaft of the bone was divided just below the head. It was then displaced inwards, and the cut surface wired to the freshened tibial extremity somewhat to its outer edge

The skiagrams (*Figs.* 398 and 399) show the growth of the shaft in its new position, and the share taken by the isolated head of the fibula in establishing bony communication with the shaft, and in contributing to its growth.

FIG. 399.—W. P. Upper end, 1908.

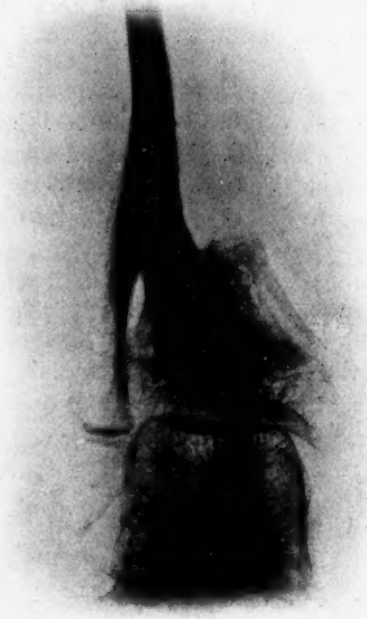


FIG. 400.—W. P. Lower end, 1908.

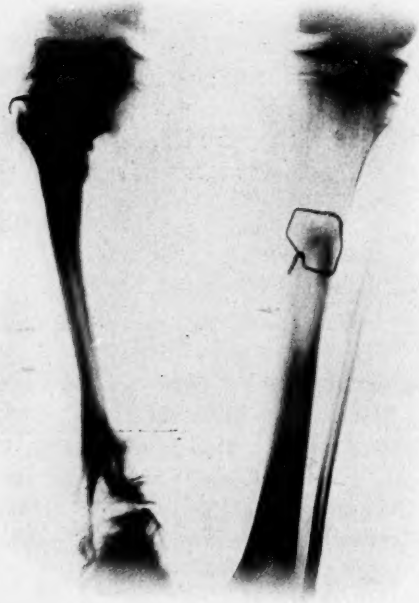


FIG. 401.—W. P. Condition in 1910.

FIG. 402.—W. P. Condition in 1913.
(The figure is reversed.)

In May, 1908, the lower end of the shaft was divided above the external malleolus and embedded in the cancellous tissue of the lower tibial epiphysis.

Owing to the contraction of the soft tissues of the limb, due to the absence of the tibial framework, considerable pressure was exerted on the lower end of the shaft, and this gradually forced the end of the bone deeper into the spongy tissue until it eventually passed right through the epiphysis, and the skiagram (*Fig.* 400) shows it abutting on the articular cartilage, and almost passing through into the joint.

Skiagrams (*Figs.* 401, 402) show the changes undergone by the transplanted bone, and the gradual assumption by it of the structure and contour of the tibia, as in the last case.

FIG. 403.—W. P. Subperiosteal operation, fracture of fibula.

FIG. 404.—W. P. 3 months later. Repair of operative fracture of fibula.

Unfortunately, in this case the disease also affected the left tibia. *Fig.* 397 shows an area in the upper part of the shaft in which a localized necrosis has destroyed about two inches of the bone, thus producing a bad antero-posterior deformity of the limb at this spot.

In order to correct this deformity, in August, 1908, one and a half inches of the soft bone were removed, and the ends of the divided shaft wired together in true alignment. This necessitated a sub-periosteal division of the fibula at the corresponding level.

Fig. 403 shows the overlapping ends of the fibula lying side by side in their common periosteal covering soon after the operation. Two separate medullary cavities, each with its outer and inner wall of denser bone, can be distinguished. *Fig.* 404, 3 months later, shows that where these two compact walls lie in

contact, absorption has occurred, forming one medullary canal. *Fig.* 405, a year after operation, shows a perfectly restored shaft with a single central medullary canal and no callus. It is, in fact, impossible now, from an examination of the limb or the skiagram, to say that a fracture had previously occurred at this spot.

FIG. 405.—W. P. A year later. Complete repair of operative fracture. Restoration of internal and external contour of bone.

Fig. 402 shows the condition of the bones in both legs in March, 1913. *Fig.* 406 shows the boy at the age of 11, in 1908. He now walks well, without artificial assistance except for a thickened sole, and goes three miles to school daily.

The progress of recovery was unfortunately interrupted in this case by an injury to the anterior tibial nerve during the operation on the upper end of the bone. This led to paralysis of the extensor muscles of the front of the leg and foot. An attempt was first made to overcome this by nerve anastomosis. The lower or distal end of the injured anterior tibial nerve was sutured to the proximal end of the divided musculo-cutaneous nerve; but the result was not satisfactory. Accordingly at a later date, in order to counteract the foot-drop, the peroneus brevis tendon was divided at the base of the fifth metatarsal bone, drawn out of the peroneal sheath through an incision above the ankle, carried across the front of the ankle, and sutured to the tendon of the tibialis anticus muscle.

This tendon-grafting operation was followed by considerable improvement in the power to lift the foot and toes off the ground in walking.

FIG. 406.—W. P. October 11th, 1908. 12 months after operation.

Surgical Result.—Surgically speaking, the end results of bone transplantation in both these cases (in one of which amputation had been suggested) can, I think, be called satisfactory.

The functional result is good. Both children can walk and run well without

assistance, the girl without any noticeable limp, and the boy with only a slight one. From the surgical point of view the problem is how to secure the continuous growth in length of the transplanted shaft, and how thus to prevent the shortening of the limb which occurred in both these, as in other recorded, cases. In regard to this question of stunted growth, no doubt much will depend on the extent to which the disease which destroys the original shaft also damages the osteogenetic capacity of the epiphyseal cartilages, especially the one which exercises the greatest influence on the growth of the leg bones.

It was with the double object of restoring this capacity of bone formation to the damaged epiphyseal cartilage, and of counteracting the deformity of the limb caused by the unopposed growth of the fibula, that I performed the operation to be described in the next case.

CASE III.

C.H., a child aged 4, developed, in 1903, a tuberculous focus in the upper epiphysis of the left tibia which partly destroyed the epiphyseal growing line. After abscess formation and recovery a considerable deformity was left,

FIG. 407.—C. H. Before operation. (The figure is reversed.)

FIG. 408.—C. H. After operation. (The figure is reversed.)

and the limb was carried inwards at a sharp angle below the knee, by the unopposed growth of the fibula on its outer side. *Fig.* 407 shows the condition of the bones before operation.

In November, 1905, the left fibula was divided just below the head of the bone, and this with the epiphysis was removed. A V-shaped portion of bone was then removed from the inner side of the head of the deformed tibia in the

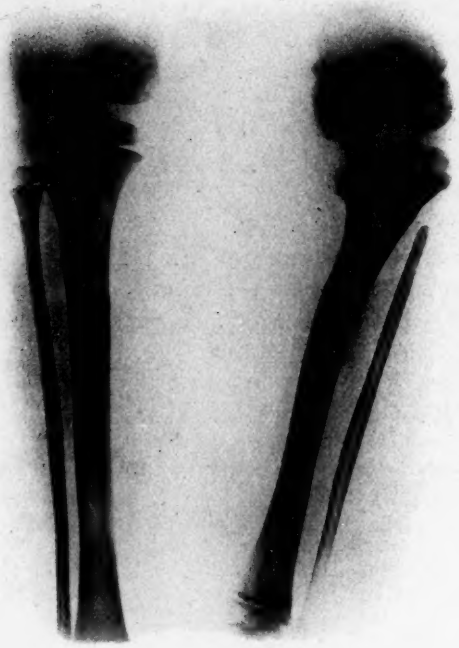


FIG. 409.—C. H. Condition in 1909.

FIG. 410.—C. H. Condition in 1913. (The figure is reversed.)

situation of the normal epiphyseal junction. The deformity was then corrected by forcibly straightening the shaft of the bone. The removed head of the fibula was now cut down to a V shape, and was inserted into the wedge-shaped gap in the head of the tibia so formed, and the wound was closed. In this way a piece of new and growing epiphyseal cartilage, taken from the head of the fibula, was introduced into the inner side of the head of the tibia in the situation of the damaged epiphyseal line. *Fig.* 408 shows the condition of the bones after operation. The grafted cartilage healed well in its new position. *Fig.* 409 shows the bones in 1909, and *Fig.* 410 the bones in 1913, and *Fig.* 411 the condition of the limb in 1909.

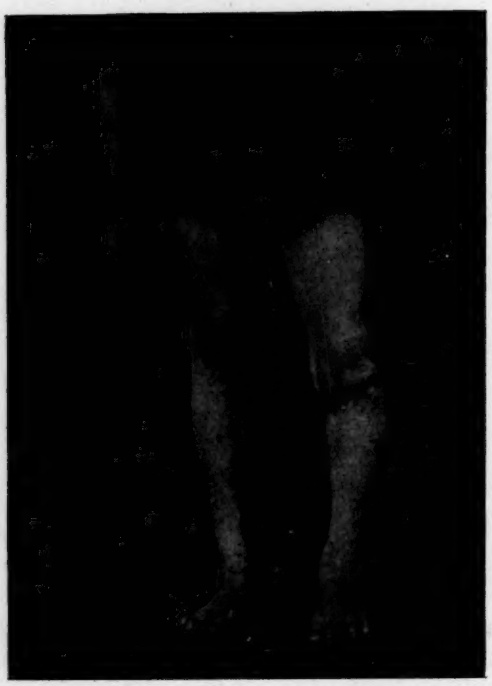


FIG. 411.—C. H. Condition in 1909.

The child now walks fairly well. There is, however, still some shortening of the limb and some internal rotation of the foot, showing that the growth of the tibia has not kept pace with that in the opposite limb.

PHYSIOLOGICAL RESULTS.

Several interesting problems arise out of a consideration of these cases.

I.—What are the controlling factors which direct the growth and development of the transplanted bone and cause it to take on the size and shape of the tibial shaft which it has replaced?

This question is of course intimately connected with the corresponding problem of the factors concerned in the development of normal bones. Macewen's important work on this subject[2] seems to show that the periosteum, if entirely free from wandering and adherent osteoblasts, is not itself concerned in bone-growth and bone-regeneration; its office is rather to limit the proliferation and control the activity of wandering bone-cells. There is only one fact, so far as I know, that seems at first sight to be opposed to Macewen's view of periosteal function, and that is, that when a new bony casing or involucrum is thrown out round the necrotic shaft of a long bone, that case is thicker opposite the middle of the shaft than at the ends. This is well seen in Nichol's cases[3] and in specimens in the Royal College of Surgeons' Museum. Now if the new bone is formed by the epiphyses, and not by the periosteum covering the dead shaft, then we should expect it to be thickest in the situations where it is first deposited, namely at the ends. The apparent anomaly may be due to the fact that as the intensity of the infection is greater in the middle of the shaft than at the ends, more osteoblasts escape from the bone in this situation, and become adherent to the periosteum at this point.

As far as they go, these observations on the growing shafts of transplanted bones also confirm Macewen's view. The lateral enlargement, or thickening, as opposed to the lengthening of the transplanted bone in each case, began at, and proceeded from, the ends or points at which it had been brought into bony contact with epiphyseal influences. Further, one is much struck by the active part played by the isolated extremities (from which the shaft has been removed) in bringing about the thickening of the shaft in its new position. A thick shadow of new bony growth can be seen issuing from the cut end of the isolated head of the fibula, passing across to, and welding it with, its old shaft in its new position. This bony outgrowth, in the upper end in *Case I*, and in the lower end in *Case II*, acts as an important strut or buttress to the transplanted bone.

In *Case II* the isolated external malleolus provides most of the new bone required for the thickening of the transplanted shaft. *Fig.* 400 shows that the shaft of the fibula, where it was inserted into the tibial epiphysis, actually atrophied instead of increasing in size. Two streams of bony material can be seen flowing,—from the old tibial epiphysis on the one hand, and the detached malleolus on the other. These unite in, and join round, the lower part of the transplanted shaft. *Fig.* 402 shows that eventually the new tibia takes the line of the old external malleolus from which it was grafted, rather than that of the tibial epiphysis into which it was inserted.

This fact is interesting, because it bears on an important biological and physiological problem,—namely, that of economy of material and energy in the growth of any part or organ. It would seem that, if the physiological and

developmental requirements of a bone as a whole are sufficiently provided for, the exact share taken by the individual parts (in this case the two epiphyses) is of less importance. It is, I think, probable that the active part taken by these osteoblasts of fibular origin in bringing about increased (and, from a fibular point of view, abnormal) growth in the transplanted bone, is really the result of an influence exercised on the growth of the bone by osteoblasts which come from the tibial epiphysis.

The point is also interesting surgically, because we have here brought about, unintentionally and by natural means, a result which surgeons have attempted to secure intentionally by operation.

Thus J. S. Stone,[4] impressed with the probable importance of preserving some bony continuity between the new tibia and the external malleolus, deliberately split the lower part of the fibular shaft longitudinally, and fixed the inner half to the tibial epiphysis, leaving the outer half in direct bony connection with the external malleolus.

E. A. Codman[5] records a case in which, after destruction of the tibial shaft, the upper end only of the fibula was grafted on to the epiphysis. Even in this case the lower end of the fibula eventually became fused with the lower end of the tibia, not as the result of operation, but of natural growth under new conditions.

There seems, in fact, to be a great tendency for these isolated epiphyses to link themselves up again with diaphyseal bone. No doubt the presence of a strip of periosteal membrane (if such remains) between the separated bones, would serve as a path or scaffolding, a line of least resistance, along which the bone-cells might travel. Thus Nichol sews the sides of the periosteal tube together after removal of the necrotic bone.[6] But apart from this, it is as though the osteoblasts coming from the epiphyseal line of growths are actually attracted by osteoblasts springing from a neighbouring shaft. The existence of some attraction between osteoblasts of epiphyseal and osteoblasts of diaphyseal origin becomes of even more importance when we remember the undoubted fact that the presence of a connecting shaft or a bony bond of union between two epiphyses is a necessary factor in the growth of those epiphyses. The absence of this connecting bony shaft, in cases in which the destruction or removal by operation of a portion of a shaft has been so extensive as to prevent the restoration of bony continuity by growth from either end, is the real cause of the retarded development in the epiphyses of the cases here described, for the final result shows that the disease which destroyed the shaft of the tibia did not destroy (though it may have damaged) the growing epiphyseal cartilages in either case. *Fig.* 401, *Case II*, shows distinctly that the inner side of the tibial epiphysis, where no direct connection exists between it and the new shaft, is still stunted and atrophic, whereas the outer part, to which the new shaft is directly attached, has grown vigorously.

The skiagrams taken before operation in both cases show a thin layer of bone on the diaphyseal side of the epiphyseal cartilage, a sort of feeble attempt on the part of these cartilages to restore the new shaft. This attempt failed, however, owing to the lack of some bony continuity between them which could act as a stimulus to their growth. In *Figs.* 392, 393, 394, *Case I*, the portion of original fibula between the head of the fibula and the new shaft seems to be much

thickened, owing, as is now suggested, to the influence of osteoblasts of tibial ancestry. It is to this layer of re-formed bone, on the diaphyseal side of the epiphyseal cartilage, that the end of the transplanted shaft was fixed in both cases. In *Case II*, owing to the very soft and friable condition of this bony layer, the end of the fibula pressed right through the epiphyseal cartilage, through the thickness of the epiphysis itself, and *Fig.* 400 shows it lying up against the surface of the articular cartilage and almost penetrating into the joint. These facts are important when we try to estimate the relative share contributed towards the growth of the new bone by osteoblasts from the transplanted shaft, from the fibular extremities, and from the tibial extremities, respectively.

II.—How does it come about that the increase in length of the new shaft is so slow in comparison with that of the tibia of the opposite leg, seeing that the increase in thickness is so considerable, and that the shaft is in bony contact at each end with a tibial epiphysis, each of which, as we have already seen, is contributing towards its growth?

It is, I think, quite clear that the epiphyseal cartilages, at any rate the upper one, cannot have contributed much to the length of the new shaft, because the wire which was originally introduced to secure the upper end of the transplanted fibula to the epiphysis still occupies its original position near to the cartilage.

Macewen found that metal caps placed over the ends of a divided shaft, near the growing cartilages, moved away from these cartilages quite a considerable distance during the growth of the bone. Although the growth in length has been much less than normal, there has yet been a considerable increase during the eight years and the five years respectively, which have elapsed since the operation in each case. The shortage amounts to nearly four inches in the girl's case, and rather less in that of the boy. This partial failure of growth in the long direction must, I think, be associated with the feeble development of the epiphyseal growing line, as seen in the skiagrams in each case. In some of these, the epiphysis and the diaphysis seem continuous, and the cartilage almost absent. This may be due to damage done by the original infection, or to the length of time which elapsed after the destruction and removal of the shaft before the epiphyseal cartilages were again linked up by bony union, and again received their normal stimulus to growth.

III.—What are the conditions which determine the lateral increase?

The physiological repair of the operation fracture in the left fibula (as recorded in the skiagrams), and the restoration of the original contour of the shaft out of the two overlapping broken ends, shows what can be done by diaphyseal osteoblasts, apart from the epiphyseal cartilages, in restoring not only the external outline, but also the medullary canal, of the original bone (*Figs.* 403, 404, 405). One can thus understand the osteoblasts of the shaft of the transplanted fibula restoring the normal outline of a fractured fibula, or even forming a new fibular shaft; but in this case they have done more than this, they have made a new tibia. A glance at *Fig.* 402 shows that not only

has new bone been deposited on the outside of the shaft, but the medullary canal has been enlarged, and the bone thus approximated to the shape of the normal tibia.

This must be the outcome of original hereditary capacity on the part of the osteoblasts concerned, as well as the result of new pressures and strains experienced by these bone-cells during their growth under altered conditions. This must mean that, although a considerable amount of young bony material may have been supplied by osteoblasts from the shaft and ends of the fibula, yet the real task of modelling the new bone thus thrown out, and of depositing it in the right situations, must fall upon the osteoblasts of tibial ancestry, upon bone cells which are thrown out by the tibial extremities after these have been re-joined by the interposition of a new shaft.

FIG. 412.—Calcaneo-tibio-fibula bone.

The way in which osteoblasts derived from three separate bones may work in co-ordination to build up bony trabeculæ in situations of stress, is well shown in *Fig.* 412, from a case of Mr. Carter's at the Leicester Royal Infirmary, in which the astragalus and ankle-joint had been previously removed in a young subject for tuberculous disease. The arrangement of the bony trabeculæ in this newly-formed calcanec-tibio-fibula bone are well suited to carry the weight of the body, and this result has been arrived at by osteoblasts of tibial, of fibular, and of calcaneal origin, each taking a share in the production of a new bone.

The key-note of all bone development seems to be a co-ordinated arrangement of bone-cells in lateral and end-on relations to each other, under the stimulus of pressure and strain, within certain limits of innate capacity.

It is interesting to compare the exuberant attempts at repair made by the epiphyses, with the scanty growth formed by the cut end of the shaft of the same bone.

Fig. 409 shows the upper end of the shaft of the fibula after the *entire* removal of the upper epiphysis. There is very little attempt at growth. I have already drawn attention to the possible existence of a mutual attraction between osteoblasts of the epiphysis and those of the shaft which causes these cells to take up definite positions in relation to each other, and alignments which provide for the deposition of bony trabeculæ in suitable situations.

We have also considered the necessity of a bony connecting medium or shaft which can link up the growth activities of both epiphyses. A diaphysis seems to be essential to the proper development of all epiphyses.

Thus the fibula in both *Case I* and *II* showed no increased growth, it made no attempt to take on new developments, as long as it was connected with its own epiphyses, even though the tibia had been destroyed and it was exposed to new strains; but as soon as the shaft of this fibula became attached to tibial epiphyses, it began at once to assume a new outline and to grow like the tibia. This fact suggests that it was the influence of osteoblasts from the tibial epiphyses which brought about the change and started the growth of the transplanted bone along tibial lines. The real question is, whether osteoblasts of fibular origin could form a bone of tibial shape out of a fibular shaft if they were placed under tibial conditions of strain and pressure, unless they were also in communication with osteoblasts of tibial origin. As far as our knowledge goes, it is the hereditary character of the osteoblasts concerned which determines the limits within which it is possible for such bone-forming cells to respond to new conditions. These limits may vary in different bones and in different species of animals. The actual testing of this point on animals by transplanting an intact fibula to take the place of a tibia after entire removal, would probably throw light on a difficult problem.

Rutherford Morison puts this same question in a somewhat different way.[7] He asks "Why is the fibula naturally a small bone and the tibia naturally a larger bone?" and in confirmation of Murphy's statement that "The amount of growth in a bone depends on the need for it," Morison instances the moderate degree of hypertrophy that occurred in the fibula in a leg in which the tibia had been destroyed eight years previously, and no attempt had been made to replace it. I feel inclined to suggest that everything depends on whether or not the transplanted bone comes under the active influence of osteoblasts from some growing area of the bone which it partially replaces. This will depend largely on the situation and the vitality of the bony connection established between the graft and the bone on which it is grafted. It is a suggestive fact that the only portion of the transplanted fibula that did show some growth in the leg case described by Morison (see *Fig.* 239, BRIT. JOUR. SURGERY, No. 3, page 382), was the part which was in intimate bony connection with the upper tibial epiphysis. The lower end, which was only connected with tibial bone by fibrous tissue, failed to develop. Moreover, in the arm case also described by Morison, I should attribute the apparent inability of the transplanted fibula to grow to the size and shape of the humerus, to the fact that the bony connection with the head of the humerus, on which its stimulus for growth depended, was insecure. Even at the lower end, where it was joined with diaphyseal bone (which is of less value as a developmental stimulus), considerable callus was said to have been present.

The fact that in my own and in other cases the transplanted fibular shaft did develop into a bone of the size and shape of the tibia, shows that the failure to do so in some cases is not due primarily to the fact that the transplanted bone is "naturally" a smaller bone, but to the fact that it is not sufficiently taken over, or its growth is not sufficiently stimulated, by osteoblasts of tibial origin.

The explanation of the undoubted fact, so admirably demonstrated by Macewen and Stiles, that gaps in the shaft of a long bone like the tibia, if not too extensive and if surrounded by healthy periosteum, are filled up by

new bone, must be, I think, not that the new bone is supplied by the periosteal membrane, but that (as Macewen has shown) the gaps are filled by growth from the ends of the divided shaft under periosteal limitation and control.

It may not be entirely useless to regard for the moment an individual bone as an organ, to think of it as composed of a mass of bone-cells of definite ancestry, whose activities are exercised in becoming adapted to a physical environment of definite stress and strain, just as we think of any other organ, for instance, the liver, as made up of a mass of cells of another ancestry adapted to respond to a different environment—a chemical environment—of proteids and carbohydrates and other chemical substances, some beneficial, some harmful to the organism. The bone-cell colony has its investing and limiting membrane, its periosteum, just as the liver has its capsule, and as Macewen has shown, this periosteum or bone-capsule serves to keep the bone-cells within circumscribed limits, and prevents them from invading neighbouring tissues.

As to the cellular origin of this fibrous membrane which forms the capsule of the bone-cells, it is generally held that it is produced by the bone-cells themselves. Thus Hey Groves[8] says that "bone is certainly the mother of (i.e., produces) the periosteum." May it not be, however, that at any rate those cells which form the fibrous part of the periosteum are derived from the connective-tissue cells of the limb or part of the body in which the bone is developing. This is an important point, because it is one which arises in the case of the capsule of every organ. If the epithelial cells of the liver and kidneys do not form the fibrous investment which envelops these organs, it is probable that the bone-cells do not form the fibrous periosteum.

Many years ago[9] I put forward the suggestion that, from the biological and ontological point of view, the capsule of any organ must be regarded as the expression of a reaction made by less differentiated cells against the encroachment of cells of a more specialised kind. Regarded in this way, the periosteum of a bone, like the capsule of any other organ, is due to the active growth of surrounding tissue-cells under the stimulus of invasion by cells of another kind. The only difference between the periosteum, or capsule of a bone, and the capsule of the liver, is that in the former case the reaction is made by mesoblastic cells against invasion by mesoblastic cells of another kind, whereas in the latter case the reaction is made by mesoblastic cells when invaded by epiblastic cells.

REFERENCES.

[1] *Ann. of Surg.*, 1905, xli, 249.
[2] *The Growth of Bone*, Glasgow, 1912.
[3] *Jour. Amer. Med. Assoc.*, 1914, Feb. 3.
[4] *Ann. of Surg.*, xlvi, 628.
[5] *Ibid.*, xlix, 820.
[6] *Jour. Amer. Med. Assoc.*, 1904, Feb.
[7] *Brit. Jour. of Surg.*, i, pt. 2, 376.
[8] *Ibid.*, 495.
[9] *Proc. Leicester Med. Soc.* 1886, and *Lancet*, 1911, ii, Aug. 5.

RADICAL OPERATION FOR CHRONIC OSTEOMYELITIS.*

By SETON PRINGLE, Dublin.

Most general surgeons have in recent years been so much interested in abdominal work that there has been a failure, I think, to make as much progress as there should have been in other important, though perhaps less interesting, branches of surgery. It may be well, therefore, to call attention to one condition, chronic non-tuberculous inflammation of bone, in which the present-day management is much the same as it was thirty or forty years ago.

The cases of chronic osteomyelitis which come to the surgeon may be divided roughly into two classes:—(1) Those with one or more sinuses which have been discharging continuously for months or years, ever since an attack of acute osteomyelitis: (2) Cases with recurrent abscess. In the latter class, a patient will usually give a history of an attack of acute inflammation many years ago; the inflammation was followed by suppuration and discharging sinuses which finally cleared up, either with or without an operation, leaving the bone permanently deformed, thickened, and with a lowered resistance. Months or years afterwards, the inflammation lit up again, an abscess formed, and a cavity in the bone was discovered by skiagraphy or at operation.

Fig. 413.—Case of chronic osteomyelitis of tibia (diagrammatic.)

The treatment of either class by the methods generally in use is essentially the same, and differs only in degree. The surgeon opens up the cavity, removes necrotic or diseased bone, and thoroughly clears out the interior. This procedure leaves a cavity in the bone of varying extent, sometimes amounting to a gutter extending from one epiphyseal line to the other. This cavity differs from that left in the soft tissues after clearing out an abscess, in that its walls are formed by a firm, non-yielding structure which cannot fall in and assist in the process of obliteration. Thus, apart from all pathological causes, there exists a great mechanical obstruction to the obliteration of the cavity by regeneration of the tissues, and in the great majority of cases a suppurating space remains in the bone, with persistent sinuses. Many methods for facilitating the obliteration of such a cavity have been tried. The skin-edges of the wound have been encouraged to fall in and become adherent; the walls have been lined with Thiersch grafts; the cavity itself has been

* Being a paper read before the Surgical Section of the Royal Academy of Medicine in Ireland, January 9th, 1914.

filled with bone chips, muscle flaps, and pastes of various kinds. The multiplicity of these methods is the best proof of the lack of general success of any one of them, and we all have had experience of the great difficulty there is, and the numerous operations that are required, in order to induce these cases to heal soundly.

It is necessary, in considering the question of the treatment of wounds in bones with loss of substance, to remember one difference between the process of healing in bone and that in other tissues. After a wound in the soft tissues with loss of substance, continuity is restored by scar-tissue, whereas in bone, actual regeneration takes place, so that as long as the regenerative power is not destroyed, any bone removed will be replaced by newly-formed bone.

FIG. 414.—Shows the soft parts, including periosteum, raised off the bone (diagrammatic.)

Personally, I had found most unsatisfactory results from the treatment of chronic osteomyelitis by the ordinary procedures; two years ago, therefore, I decided to try a more radical method, somewhat on the lines suggested by Beck.[1] The results have been so uniformly satisfactory that I determined to bring the matter forward, in the hope that other surgeons would give the method a trial. The operation aims at removing all diseased bone, and leaving no resultant hard-walled cavity behind. Advantage is taken of the fact that, in most cases, one surface of the bone is formed of new bone not involved in the inflammatory process. The general lines of the operation will be more easily understood by reference to the drawings. *Fig.* 413 depicts a case of chronic osteomyelitis of the tibia, involving almost the entire length of the diaphysis, and with multiple sinuses. An incision has been made right down to the bone, extending to normal bone at both ends, which are curved off in order to facilitate the next step. *Fig.* 414 shows the soft parts, including the periosteum, raised off the subcutaneous and posterior surfaces of the bone, the periosteum being carefully preserved except where a sinus occurs: in that case it is necessary to excise the sinus. In *Fig.* 415 we see the whole of the diseased, and some of the healthy, portion of the bone has been removed in such a manner that the bone left is rounded off, so that there are no steep walls or ridges which will prevent the soft parts from falling in and obliterating the cavity; at the same time a narrow strip of bone connecting the healthy upper and lower extremities

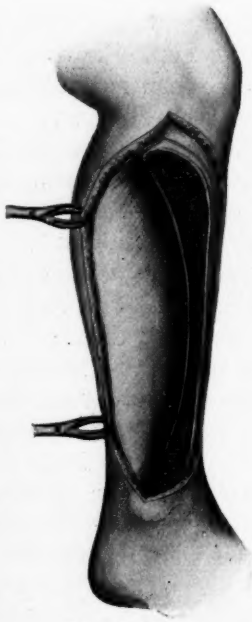


FIG. 415.—Shows the diseased bone removed (diagrammatic).

has been left to maintain the continuity. The situation of this strip will of course vary in different cases; in the tibia, as a rule, the external or fibular surface is not perforated by cloacæ, and is the most normal part of the bone. In the case of the forearm or leg, I do not hesitate to remove the entire circumference subperiosteally, should it be impossible to get a strip of healthy bone, since in these places we have the second bone to maintain the length and position of the limb while the new bone is being formed. *Fig.* 416 shows the wound closed by through-and-through sutures, with the end of a gauze plug protruding. Too many sutures are shown; it is unwise and unnecessary to co-apt the edges of the wound very accurately.

FIG. 416.—Operation completed, with gauze plug protruding (diagrammatic).

As regards the after-treatment, the plug of gauze is removed in a few days, a moist dressing applied, and the limb tightly bandaged, with the object of pressing the soft parts in and thus obliterating the space. Suppuration will, of course, continue for a few weeks, just as in a septic cavity in the soft tissues; but it rapidly clears up, and if the operation has been properly planned and carried out, the periosteum will adhere to the raw surface of the bone, the wound heal up, and regeneration of bone proceed quickly.

FIG. 417.—*Case* 1. Chronic osteomyelitis following an acute attack sixteen months previously.

Up to the present I have operated on twelve cases by this method. The only fatal case was that of a weakly boy, where the whole diaphysis of the femur was involved. Suppuration had been going on for fifteen months, with many sinuses continuously discharging. Unfortunately he died under the anæsthetic (ether),—death, I think, being due to degeneration of the heart-muscle caused by the prolonged toxæmia. I do not consider that the special method of operation which I am advocating can be blamed for this fatal result, as it would probably have occurred no matter what operative procedure had been employed.

I have had a series of *x*-ray photographs taken of my first four cases, and brief notes of these cases are as follows :—

Case 1.—A boy, aged 9, was the subject of acute osteomyelitis sixteen months before admission. He had been operated on four times in a children's hospital. Examination showed that the upper half of the diaphysis of his tibia was extensively involved, and there were three sinuses leading down to the bone. An *x*-ray photograph (*Fig.* 417) demonstrated the condition. An operation, as outlined above, but

FIG. 418.—*Case* 1. Three weeks after operation. The sinus had been injected with bismuth, showing the small size of the cavity.

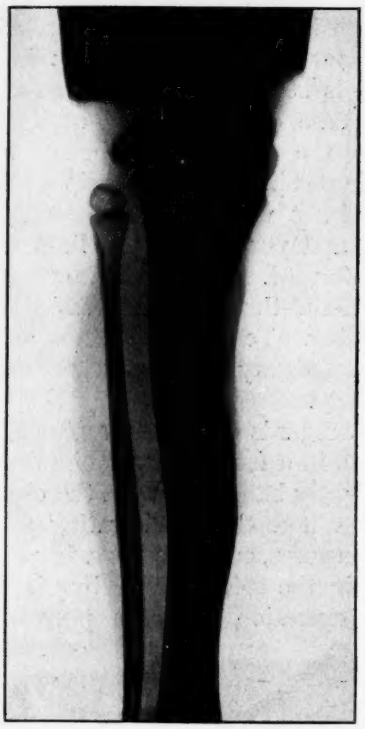


FIG. 419.—*Case* 1. Twelve months after operation.

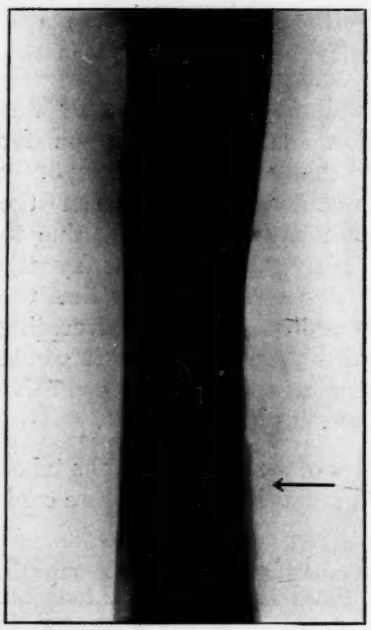


FIG. 420.—*Case* 2. Osteomyelitis of tibia of long standing. The arrow points to a large cavity.

FIG. 421.—*Case* 2. Four months after operation.

FIG. 422.—*Case* 2. Nine months after operation.

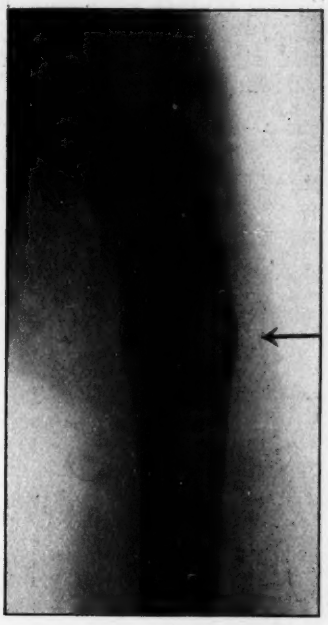


FIG. 423.—*Case* 3. Fracture of femur in boy, followed by abscess. The arrow points to abscess cavity.

FIG. 424.—*Case* 3. Immediately after operation.

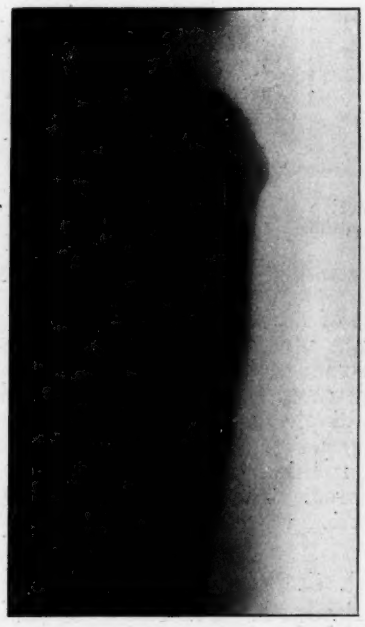


FIG. 425.—*Case* 3. One year after operation: complete restoration of bone.

FIG. 426.—*Case* 4. Osteomyelitis of tibia.

limited to the upper third or so of the bone, was performed. *Fig.* 418 illustrates the condition three weeks afterwards; the cavity had been injected with a bismuth paste, and its small size is well shown. The wound was completely healed in five weeks, and has remained so. A photograph taken eleven months later demonstrates the new bone-formation (*Fig.* 419).

Case 2.—A man, aged 30, had suffered from osteomyelitis of the tibia as a child. There had been no discharge nor sign of active disease for fourteen years until several months before operation, when he complained of pain in the lower end of the bone. A swelling appeared, and some two weeks before admission an abscess burst and was still discharging. A probe passed down the sinus obviously entered a cavity in the bone. An *x*-ray picture showed a large cavity in the lower end of the tibia, with a cloaca (*Fig.* 420). A similar operation to the above was carried out, and the wound healed in three weeks. The condition of the bone, four and nine months afterwards respectively, is shown in *Figs.* 421 and 422. The new bone-formation can be well seen. The leg has remained perfectly well ever since, and the patient returned to his work as a labourer two months after operation.

FIG. 427.—*Case* 4. Showing active regeneration of bone three months after operation.

Case 3.—A boy, aged 14, fractured the upper third of his femur three years before coming to me. The fracture was plated in another hospital; but the plates had to be removed a year later on account of abscess-formation. The abscess quickly healed, and he suffered no further trouble until several weeks before he came under my care, two years later, when there was obviously a large abscess in the thigh. The *x*-rays showed a small cavity in the centre of the bone (*Fig.* 423). I operated by the same method, and the result is shown in *Fig.* 424. Five weeks later the wound had healed soundly, and the boy was discharged. A radiogram taken a year after operation shows complete restoration of the bone (*Fig.* 425).

Case 4.—A boy, aged 7½, had an attack of acute osteomyelitis of the tibia fifteen months before coming under my care. He had been operated on several times. Examination showed that almost the whole diaphysis of the tibia was involved; there were numerous sinuses, the uppermost of which ran upwards towards the knee-joint and penetrated the epiphysis. A large sequestrum of the shaft was partially extruded. *X*-ray photographs of the bone demonstrated that the lower 1½ inches was practically normal, but the remainder of the diaphysis and also the epiphysis were very extensively diseased (*Fig.* 426). An operation identical with that illustrated in the drawings was performed, the sinus running into the upper epiphysis was cleared out, but the epiphysis itself was spared. The wound healed in three months, and a radiogram (*Fig.* 427) showed active regeneration of bone.

In one case in which the radius was the bone affected, I removed the whole upper half of the diaphysis. The notes on this case are as follows:—

Case 5.—The patient, a boy, aged 12, fell on his left elbow. Some days afterwards he was seized with a sudden pain in the forearm, accompanied by great swelling

and tenderness. On examination, three months after the onset, I found a hard, irregular swelling of the upper half of the left radius, with fluctuation at one point. The elbow was flexed at an angle of 125°, and only some 10° of movement could be obtained, while the power of pronation and supination was completely lost. *Fig.* 428 is from the *x*-ray plate taken at the time. At the operation, I divided the radius

FIG. 428.—*Case* 5. Osteomyelitis of radius before operation.

FIG. 429.—*Case* 5. Condition five weeks after operation.

below the level of the new bone-formation, and shelled the upper fragment out of its tube of periosteum, separating the upper extremity from the epiphysis at the epiphyseal line. The condition of the bone five weeks later is shown in *Fig.* 429. The final result is very satisfactory, both as regards the condition of the forearm and the amount of movement obtainable at the elbow-joint.

REFERENCE.

BECK, *Surg. Gynæc. and Obstet.*, 1911, Nov.

EXCISION OF THE DIAPHYSIS OF THE HUMERUS, WITH FULL FUNCTIONAL RECOVERY.

By ARTHUR J. EVANS, Liverpool.

The treatment of bone-disease and injury has, during the past decade, loomed large in surgical literature, stimulating enquiry and producing new views as to its regeneration and repair. More radical measures have been adopted in the operative treatment, with results most gratifying to patient and surgeon alike.

Fig. 430.—*Taken 15 days after removal of shaft.* This, unfortunately, does not include the upper end of the limb, but shows the greater part, with the lower epiphyseal cartilage. Evidence of osseous deposit is indicated along the periosteal tube, while the deposit of bone at the lower epiphyseal end is well-marked and abundant.

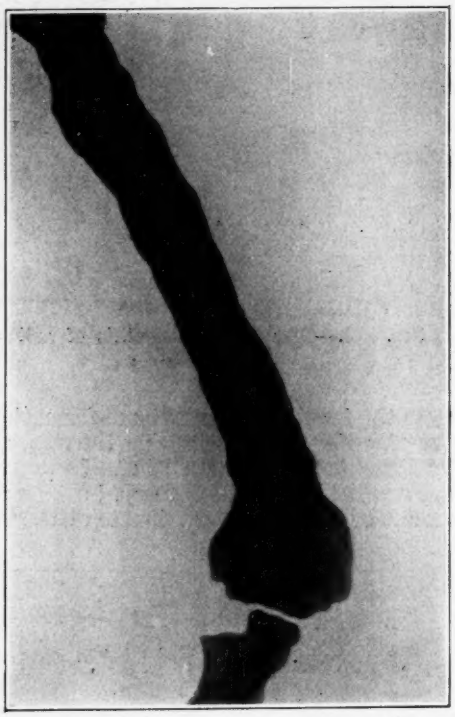


Fig. 431.—*Taken 41 days after operation.* This shows re-formation of a dense shell of bone along the whole line of shaft, with complete fusion of the diaphysis to the epiphyseal cartilage. The surface shows irregular wavy excrescences along the outer margin, while the centre of the shaft shows evidence of being still incompletely ossified.

Complete excision of the shaft of a long bone is not often resorted to, except in the case of one of the bones of the forearm or leg; here the alignment of the limb during the process of repair and regeneration can be maintained by the splint-like support of the companion bone.

In the case of the humerus and femur, no such natural support is possible.

In partial resection of these bones, various ingenious devices have been employed in order to maintain the alignment of the limb, to prevent undue shortening, and to form a scaffolding along which repair and regeneration will take place.

Autogenous and exogenous bone-grafts have been inserted, as well as foreign bodies such as metal rods, etc.

The following case presents several interesting points for discussion :—

A. S., a female child, age 5, was admitted to hospital on January 21, 1913. A week before admission she had fallen downstairs, injuring her right arm.

On examination, the right arm, from shoulder to elbow, was found to be swollen, painful and œdematous. Patient was unable to move either joint. The temperature was 101°, pulse 128.

The case presented the obvious features of severe acute osteomyelitis involving the entire diaphysis. An incision was at once made down to the humerus and pus evacuated.

The general condition of the patient was very critical at the time of admission, and therefore nothing more was done beyond employing free drainage. The local infective process appeared to have attacked both epiphyseal ends of the diaphysis simultaneously, the infection rapidly spreading up and down the bone.

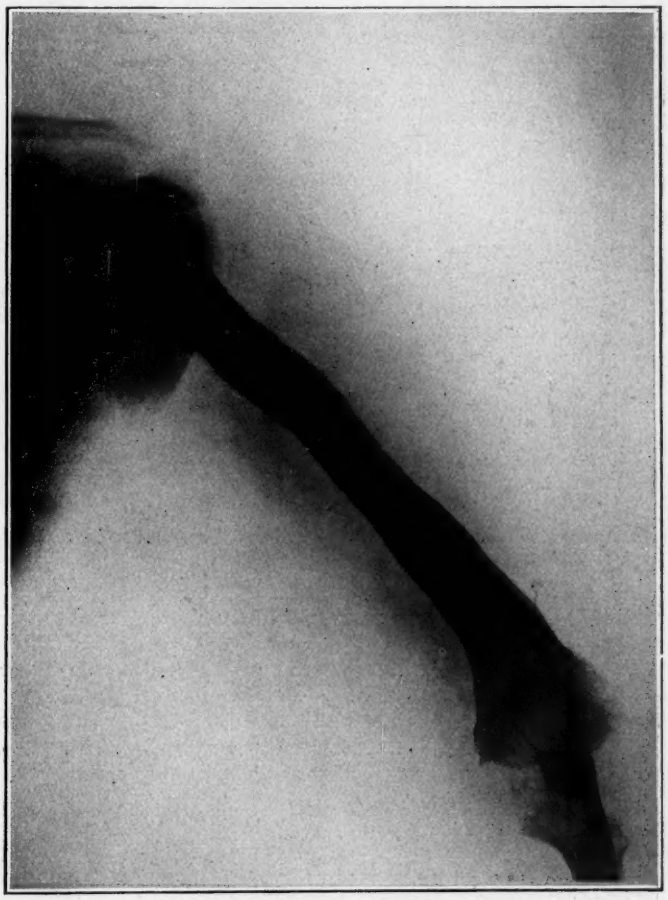


FIG. 432.—*Taken 9 months after operation.* This shows the reconstituted bone, perfectly aligned, its surface smooth and rounded off, its shaft and epiphyseal ends thicker and more dense in structure than that of the normal left humerus. The centre of the shaft, in its lower third, shows indications of absorption taking place, with the formation of a medullary cavity.

On March 3, 1913, the patient's general condition having improved, it was resolved to deal more radically with the disease.

An incision was made through the deltoid muscle down to the bone, the shaft of which was found to be devoid of periosteum and surrounded by an irregular " involucrum " of new bone. The insertions of the muscles were detached with blunt-ended scissors : a second incision was made over the back of the lower end of the humerus, the triceps muscle being split by blunt dissection. The musculo-spiral nerve, together with the profunda vessels, was identified and retracted with the periosteum. After separation, the whole shaft, consisting of sequestrum and involucrum, was then with-

drawn through the upper wound. The arm now consisted of nothing more than a flaccid tube of periosteum and granulation tissue, surrounded by the soft parts. It was placed in a specially-moulded poroplastic splint, fixed above to the axilla and below to the forearm at the elbow, the limb being so fixed that the muscles of the arm were fully extended and no contraction could take place. Drainage was provided above and below. The subsequent course of the convalescence was uneventful, the upper and lower wounds being dressed daily, after which the temperature immediately dropped to normal. Massage of the forearm and passive movements at the elbow-joint were carried out a few days after the operation.

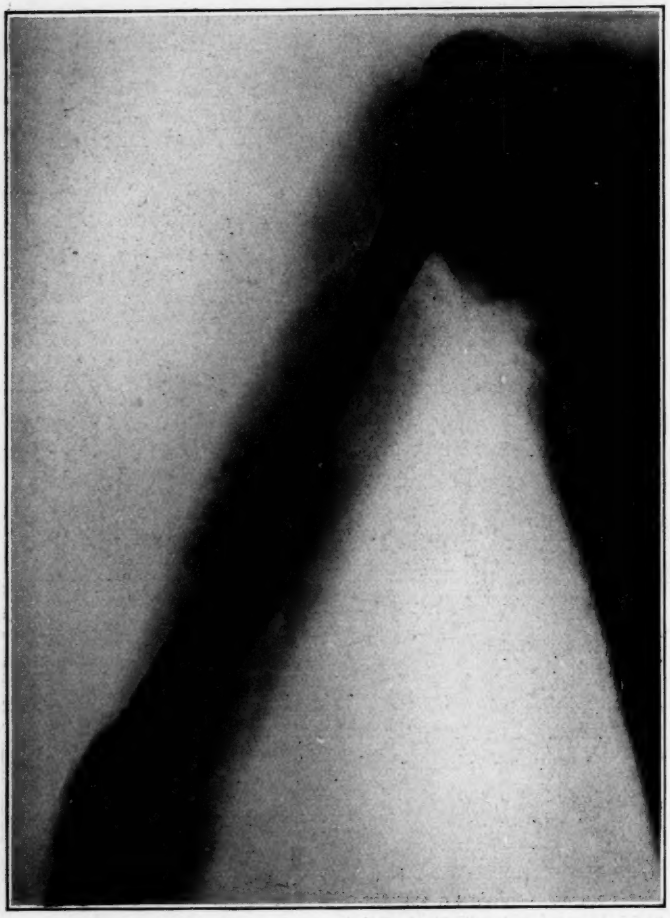


FIG. 433.—Shows the normal left humerus, taken for comparison.

Convalescence was exceedingly rapid. In three weeks' time an emaciated, exhausted patient was transformed into a robust and happy child.

Radiographic records, reproduced in *Figs.* 430, 431, 432, taken at regular intervals, show regeneration of bone taking place very rapidly along the whole length of the periosteal tube, the growth appearing as rapidly in the centre of the limb as at its epiphyseal ends.

The present condition of the child, twelve months after operation, is as follows:—

The mobility of the shoulder- and elbow-joint is unimpaired; full flexion and extension are present in the latter, while the movements at the shoulder are free in every direction.

The right arm is shorter than the left to the extent of $\frac{5}{8}$ in.; it is as strong and flexible as the other. The child can accomplish any sort of gymnastic exercise without pain or loss of power (*Figs.* 434, 435).

The cosmetic result is excellent, the contour of the limb perfect, and the slight amount of shortening is difficult to detect, the healed scars being the only observable blemish.

Macewen's recent convincing observations on osteogenesis have revolutionized our ideas on bone re-formation. Without any knowledge of his brilliant work, a glance at the above radiographs would at once remind us of the long-taught osteogenetic properties of the periosteum. It could be plainly demonstrated how the osteoblastic layer of this membrane had deposited bone in a definite layer along the whole length of the periosteal tube, thus bearing out the teaching of Ollier and others.

FIG. 434.—Patient nine months after operation, showing movements of arm.

It has been proved by Macewen, and more recently confirmed by Hey Groves, that bone, and bone alone, is responsible for its own reproduction, while the function of the periosteum is that of a limiting and nutrient membrane.

FIG. 435.—Patient nine months after operation, showing movements of arm.

In acute osteomyelitis, the accompanying intense hyperæmia of the bone produces a rapid proliferation of the osteoblastic cells within the medulla and Haversian canals; these exude on to the surface and accumulate in a layer beneath the loosened periosteum, thus simulating osteogenetic activity on the part of the membrane.

The latter, however, only confines them within its wall, its loose vascular tissue furnishing the necessary pabulum for their activity, with resultant deposit of new osseous tissue between the membrane and diseased bone.

The fact that the whole involucrum, together with the necrosed shaft, was removed at the time of operation, is a matter of great importance. According

to the generally accepted theory, established by Ollier in 1867, the involucrum is formed by the activity of the osteoblastic layer of the periosteum.

If, then, this be true during a period of unusual osteogenetic activity of this membrane, the deep layer of the periosteum should be closely incorporated with the new bone formed from it: there should be no layer of cleavage between the bone-forming membrane, and its product, bone.

I was able to "shell out" the whole of the new growth without difficulty, the line of cleavage being distinct along the whole line of shaft.

Again, examination of the removed specimen shows that the actual surface of the new bone is smooth and slightly polished, the excrescences and irregularities being due to the varying osteogenetic activities of the osteoblasts in different areas, the deposit of new bone being most marked at the distal end of the shaft (*Fig.* 436).

FIG. 436.—Diseased diaphysis, showing marked erosion of bone at upper and lower ends, the sites of primary invasion. The dead shaft is surrounded by an incomplete shell of new bone.

I do not consider it justifiable to remove the whole involucrum in every case of osteomyelitis. In this case it was done because it was firmly cemented to the diseased shaft, and easily separated from the overlying periosteum, *two* important points in favour of its reproduction from the mother-bone.

A striking feature of the case is, that the involucrum having been removed, sufficient osteoblastic tissue remained behind to completely regenerate the shaft.

"The younger the subject, the greater is the proliferating power of the bone-cells." This is strikingly shown in the above case, complete reproduction occurring within six months' time.

Finally, the case shows that, by the application of suitable external supports and assiduous attention to the patient, the most extensive resection of bone can be carried out, without resort to grafts or the introduction of foreign bodies.

(In this case, the virulent suppuration at the time of operation precluded such treatment.)

My thanks are due to Dr. Thurstan Holland for radiographs, *Figs.* 432 and 433, and to Dr. Thomas Stewart, my house surgeon, for his unremitting attention to the case.

REFERENCES.

L. OLLIER, Régénération des os. 1867.
MACEWEN, The Growth of Bone. 1912.
HEY GROVES, An Experimental Study of the Operative Treatment of Fractures. *Brit. Jour. Surg.* 1914, No. 3.

TWO CASES OF INJURY TO THE PANCREAS.

By G. GREY TURNER, Newcastle-upon-Tyne.

Any type of injury to the pancreas is undoubtedly rare, and in my fifteen years experience as house-surgeon, surgical registrar and assistant surgeon to the Newcastle Royal Victoria Infirmary, I can only remember some half-dozen cases.

In my own series up to the end of 1913, there was a total of 5333 operations. Among these, 2105 were abdominal, and the 2 cases which form the subject of this note were the only examples in which an injury to the pancreas was proved.

The protected position of this organ is in keeping with the importance of its functions, and is undoubtedly the reason why it so frequently escapes, even in severe abdominal injuries. However, cases have now been collected which show that it may be injured subcutaneously, either alone, or more commonly in association with injuries to the other viscera.

I have recorded[1] an example of the latter condition in a man of 37, who died eighteen hours after falling down a ship's hold, and the following is an account of the post-mortem examination :—

"No injury to the abdominal parietes was found. As soon as the abdomen was opened, a horribly fœtid smell was noticed. There was a small quantity of blood free in the belly; it had probably escaped from a tear in the peritoneum on the right posterior abdominal wall. The intestines were neither much distended nor did they show any gross signs of peritonitis, and there was no injury to any part. The stomach was very greatly distended, and on its anterior surface, about the middle of the lesser curvature, there was a hæmorrhage into its wall extending over an area of about 3 inches diameter, yet there was no actual rent.

"The whole of the retro-peritoneal tissue on the right side, from the diaphragm to the pelvis, was infiltrated with blood. The hæmatoma extended over the spine as far as the middle line, and had spread into the mesocæcum and the wall of the colon.

"The right kidney was found completely torn across near its centre, the two pieces being held together by the tissues of the pelvis. There was no injury to the ureter or bladder. Examining the left kidney region, the retro-peritoneal tissues were found blackened, soft and friable as if sloughing; the foul odour noticed on first opening the belly was much more marked in this neighbourhood, and was particularly nauseous. Fat necrosis was noticed in that part of the great omentum which was situated towards the left side, and was also present in the fat around the left kidney and in the extra-peritoneal fat generally along the left side of the abdomen. In the lesser sac there were a few patches, and the peritoneum was intensely congested over a small area here. The left kidney was uninjured, as was its ureter; its substance appeared healthy. The pancreas was torn completely across about one and a half inches from its left extremity, and after its removal from the body the parts were only held together by a little connective tissue.

"The pancreatic substance in the vicinity of the rent had the same sloughy appearance as the extraperitoneal fat, so that the characteristic structure was lost, and in places the organ was almost diffluent. Here and there were areas of fat necrosis between the lobules. The spleen was uninjured. A large irregular tear was found on the posterior and inferior surfaces of the right lobe of the liver, and there was a much smaller rent on the superior surface of this lobe. Between the bare area of the liver and the diaphragm there was a large hæmatoma. The liver substance was soft and fatty, but not markedly so. In the right chest there was a small quantity of free blood; the only injury to the lung which was discovered was a very small tear of the visceral pleura over the outer aspect of the lower lobe. The 7th, 8th, 9th, 10th, 11th, and 12th ribs on the right side were fractured, some of them in two places. The left lung was diffusely adherent from an old pleurisy, but was otherwise normal. The heart and pericardium were uninjured. There were no other injuries to the thoracic wall, and the spine was unharmed. The head was not examined."

Isolated injuries are much more rare, but are of peculiar interest because they usually declare themselves as the result of secondary changes to which they give rise, as in the two examples which form the basis of this communication.

Cases are, however, recorded where early interference has disclosed laceration or a tear of the pancreas, which has been repaired or treated by excision when the tail of the gland has been separated from the body, and sometimes with recovery.

Gunshot wounds of the abdomen may sometimes involve the pancreas, as in the case of the late President McKinley. In perforating abdominal injuries, the pancreas has been wounded, either alone or with some of the other viscera, or wounded and prolapsed through the parietes.

Case 1.—**Inflammatory effusion into the lesser sac of the peritoneum following a contusion of the pancreas, and complicated by an effusion into the left pleural cavity.**

The patient (A. E. H., Reg. No. 688), aged 18, was under the care of Dr. Dewhirst, of Whitley Bay, by whose kindness I was asked to see him in September of 1905.

Briefly, the boy had sustained an abdominal injury, and as a consequence had developed a large fluid swelling in the upper abdomen. Thirteen days before I saw him he was driving a light flat cart, such as is used by tradesmen, when the horse fell, the shafts broke, and the pull on the reins brought the lad to the ground. As he fell, the left side of the abdomen came in contact with the side of the cart. For a time he held on to the reins and was dragged along the ground, but he soon had to let go, and one of the wheels passed over the left side of his abdomen and chest. Although he felt "knocked out," he managed to walk to his home, a distance of half a mile, where he vomited soon after arrival. When seen by Dr. Dewhirst, half an hour after the accident, he was a little collapsed, the extremities being cold and the lips bluish; the pulse was 120, and he complained of pain at the site of the injury. Two hours later the shock and cyanosis had passed off, but the vomiting had been repeated and there was still a good deal of pain, with tenderness over the whole of the left side of the abdomen, but without any rigidity. In the evening the symptoms were similar, but there was no temperature, though on the second night it reached 101°. The pain and vomiting continued for the next three days, and the tenderness persisted, but there was no rigidity and no swelling. Urine was passed naturally and never contained blood, nor was there ever any in the vomit; the evacuations, however, were dark-coloured. On the fifth day following the accident the pain very much diminished, the temperature dropped to normal, and the pulse to 84; vomiting ceased and the lad was thought to be out of danger, though tenderness persisted

over the splenic and left lumbar regions. Everything went on favourably until the eleventh day, when the pain increased and there was a return of vomiting, and for the first time Dr. Dewhirst discovered a swelling just below the left costal margin. During the night the patient had a great deal of pain and vomited frequently, and next morning the swelling was noticed to have increased.

On the thirteenth day I first saw the patient, and found him lying in bed looking in fairly good condition, except for a bluish tinge about the lips and rather rapid respiration (36 per minute). The pulse was 104 and the temperature 99·8°. He lay easily in bed, but the least exertion brought on painful shortness of breathing. The principal complaint was of constant slight pain over the swelling, and of vomiting. Food in any quantity was rejected at once, though in small amount it was retained, so that this symptom was evidently entirely mechanical. The left upper quadrant of the abdomen was very prominent, being occupied by a large swelling which bulged out the lower part of the left chest from the level of the nipple downwards (see *Fig.* 437). The swelling was tense and tender, and a wave of fluctuation could easily

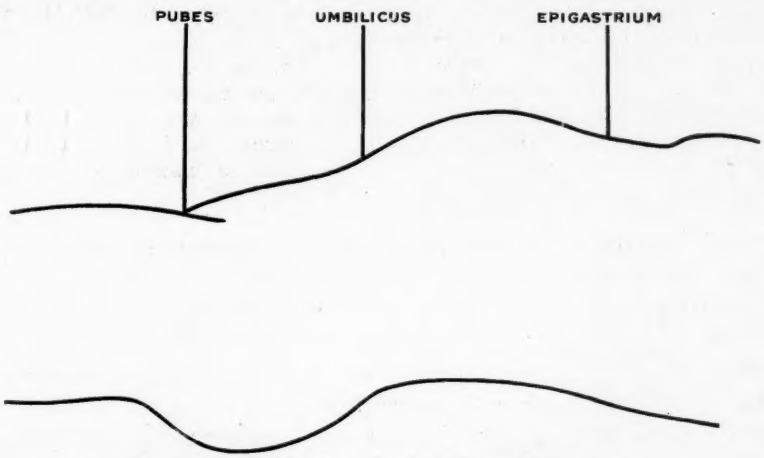


FIG. 437.—Profile view of epigastric swelling.

be obtained from any part in front to the intercostal spaces behind. It was dull practically all over. The stomach could be distinguished on the front by its shape and by gurgling. The colon was not made out, nor could the left kidney or the liver be felt. The base of the left lung was pushed upwards, but there were no adventitious sounds and the heart-apex was not displaced. There was no evidence of injury to the parietes. The urine did not contain sugar.

We came to the conclusion that the patient had an inflammatory effusion into the lesser sac, resulting from an injury to the pancreas. He was removed to a private hospital in Newcastle, and during the night had a great deal of pain with increase of the swelling. Next morning, with the patient under a general anæsthetic, I made a 3 in. transverse incision just below the left costal margin. As soon as the muscles were divided the peritoneum bulged into the wound, and with an aspirator I removed 3 pts. 6 oz. of thin fluid. By enlarging the incision I opened the cavity freely, but the only organ I could distinguish was the stomach, lying in front. Several small areas of fat necrosis were noted about the edges of the opening, and on microscopic examination showed the usual characteristic appearances. The cavity was drained by tube and gauze. Great relief followed the operation.

The fluid was of brownish colour, opaque, and without characteristic odour: it was of sp. gr. 1003, slowly turned red litmus paper blue, and on heating deposited a large amount of albumin, but contained no sugar. It readily converted starch into sugar, but apparently had no action on fibrin, nor did it make a good emulsion with fat. On standing, it threw down a large flaky deposit which consisted mostly of débris, fat, refractile granules, altered leucocytes, and particles of pigment. There

were no crystals of leucin or tyrosin. Some of this fluid was put in a bottle at the time of the operation, with a little thymol as a preservative, and now (eight years later) it has exactly the same appearance as it had when withdrawn.*

So far as the after-history of the abdominal condition is concerned, there is little to say, for it never gave rise to any anxiety. Ten days after the operation a smaller tube was substituted, and at the end of the fifth week the wound was healed. Though greatly relieved by the operation, the patient was still a little blue and had some shortness of breath, while there was a little dullness at the extreme base of the left lung, though Traube's space remained clear. By the tenth day the chest condition had improved, but there was still a limited dull area. Between this and the fifteenth day the boy was not so well. He became anæmic, and there was a return of the cyanosis. On the fifteenth day, examination of the chest showed that the dull area had increased so as to involve Traube's space, and the heart was displaced a little upwards. With the aspirator, thirty ounces of fluid were removed from the left pleural cavity. It was the colour of urine loaded with urates, or a weak Gregory's mixture, but without characteristic smell. It was strongly alkaline, of sp. gr. 1013, contained a large quantity of albumin, and on standing deposited a certain amount of blood-clot, while it slowly converted starch into a Fehling-reducing body. After this, recovery was devoid of incident, and the lad was soon able to go home.

Six months later, Dr. Dewhirst reported that the lad was quite well, the chest condition having completely cleared up. In December, 1913, the patient reported himself as perfectly well and without any weakness or bulging of the scar. An examination of the urine proved it to be free from sugar.

This case is a typical example of the condition known as traumatic effusion into the lesser sac of the peritoneum, which was very clearly described by Jordan Lloyd in a classical paper entitled " Injury to the Pancreas : A Cause of Effusions into the Lesser Peritoneal Cavity," read before the British Medical Association at Nottingham.[2] I have very carefully read and re-read his description, and so far as I know, nothing material has been added since that time. The following extract shows how clearly Mr. Jordan Lloyd understood the pathology of these cases :—

" A blow in the upper part of the abdomen, immediately below the liver, may crush the pancreas against the first lumbar vertebra ; its peritoneum covering, being thin, may be easily torn through, and bleeding will then take place into the lesser peritoneal sac. With a patient in the supine position, this blood will gravitate to the deepest part of the cavity and will be hidden behind the stomach and beneath the left concavity of the diaphragm, and may thus escape the surgeon's observation.

" This blood, doubtless, may be absorbed if the damage to the gland is slight and none of its ducts are injured ; but if a duct is torn, I imagine the secretions of the gland may be poured into the cavity with the blood ; and although Senn tells us that pancreatic juice is not irritating to the peritoneum, I fancy that a mixture of pancreatic juice and devitalized blood-clot may have a very different effect,

---

* I thought it would be interesting to have the fluid re-examined, and Professor Bainbridge has kindly done this for me with the following result :—

Fluid from abdominal swelling. T/422. Faintly acid to litmus. Sp. gr. 1015. It contains coagulable protein but no trace of albumose ; fat is present but no sugar. It has no ferment action on either protein, fat, or starch. Microscopically, no bacteria, no crystals.

Fluid from chest. T/425. Reaction neutral. Sp. gr. 1030. It contains much coagulable protein and a trace of albumose. It has no ferment action on protein or fat, nor does it form sugar from starch. Microscopically, it contains fat, no crystals, no bacteria.—*Dec.* 10, 1913.

and that chemical changes of a digestive kind may then be started which may irritate the serous lining of the sac and cause it to pour out its secretion, and thus gradually distend its cavity."

It is very important to remember that a considerable interval may elapse between the injury and the development of the effusion, and cases have been recorded in which it was as long as six months. More commonly the condition shows itself within a few days of the receipt of the injury.

The fluid does not always exhibit the characteristic properties of pancreatic secretion, for it must be clearly understood that the greater part of the effusion is poured out by the irritated peritoneum, thus diluting the pancreatic juice. Cases in which an operation is called for soon after the receipt of the injury are quite likely to contain fluid with active pancreatic secretion, but the fluid may soon lose its properties, and certainly does so after drainage has been established for a few days.

In the surgical treatment of the condition, I would like to point out the advantages of an incision below the left costal margin as a convenient situation in which to drain the distended lesser sac. An examination of the pancreatic bursa will convince anyone that when distended it must soon reach the parietes just below the spleen. In some of these cases there is no bulging, but it has been possible to drain in this situation in all that I have seen. I was lead to adopt this route by the observation of a case which had been drained from the front, and in which the sinus refused to heal, and persisted for many years. In cases of doubtful diagnosis, or in the earlier stages when direct interference with the pancreas is contemplated, the anterior vertical incision has the greater advantages, at least in the first instance.

In my case, the chest complication is an additional feature of interest. It may be that the diaphragm was injured at the time of the accident, though, as will be seen from the history, there was nothing to suggest that there was any extensive effusion into the pleural cavity at that time. It seems more likely that some bruising of the diaphragm had occurred short of an actual tear, and that this subsequently allowed the escape of some of the fluid into the chest after the base of the lung had been shut off by adhesions.

In spite of the properties of the fluid as determined by chemical examination, one would think that it cannot have been very irritating to the pleura, or it would scarcely have cleared up after a single tapping. A recent case has suggested that the fluid may have lain between the upper surface of the diaphragm and the basal parietal pleura, that is to say, outside the pleural cavity proper. In a brief search through the British literature I have only come across one other case in which there was a collection of fluid in the pleura as a complication—this was published by Thomas Kellock.[3]

Injury to the pancreas is of course not the only cause of an inflammatory effusion into the lesser sac, for it is well known as a complication of pancreatitis. Mr. Lynn Thomas[4] published a case in which an effusion simulating a pancreatic cyst followed a laceration of the Spigelian lobe of the liver.

If there is a long-continued discharge of irritating pancreatic juice from the drainage track, it may be due to a slough of the pancreas. Before carrying out any exploration it would be well to try the plan suggested by Wohlgemuth; this method is based on physiological principles, and consists in withholding carbohydrates, allowing fat freely, and giving frequent small doses of bicarbonate of soda.

Case 2.—**Contusion of the head of the pancreas followed by temporary obstruction of the duodenum and common bile-duct.**

The patient (C. H., Reg. No. 5161), aged 13, was first admitted to the Newcastle Infirmary on October 2, 1912, as a case of abdominal injury.

About an hour previously he was riding a bicycle along a narrow street when he saw a cart approaching from the opposite direction. When too late for him to dismount, he realized that there was not room to pass and that there must be an accident. As he slipped off his bicycle he bumped against the shaft of the cart, which caught him across the upper abdomen, and then passed without hurting him further. There was great pain, and he was not able to mount his bicycle again. After being seen by Dr. Mackenzie, of Gosforth, he was sent straight to the Infirmary in a taxi-cab, where I first saw him at 3.30 p.m. The Sister told me that when admitted about two hours previously he was a little collapsed and was very definitely cyanosed, and on the whole she was inclined to think that he probably had something serious the matter.

At the time of my visit I found that the shock had passed off, and that there was only a trace of the previous cyanosis. The skin over the epigastrium was grazed and there was evidently some deeper bruising. He was a little tender in the upper abdomen, but there was absolutely no rigidity, he had not vomited, and the pulse was only 92. I decided that there was probably no serious injury, but that it was a case to watch very carefully. That night the pulse went up to 100, but the temperature was never above 99·4°. Next day he seemed quite all right, and on October 4 he was allowed to go home.

Three days later he had some pain after eating, felt sick, and vomited. This was repeated two or three times during the day, and he could take no food. The pain was not severe and was confined to the region of the stomach. The bowels had been moved every day.

The patient was re-admitted to hospital on October 11. He looked in good general condition, the temperature was 99° and the pulse 80. During the night he vomited, there was marked distention of the epigastrium, and at first sight it looked as though he were suffering from an effusion into the lesser sac. On the following morning the distention had completely gone and there were no signs of any pancreatic cyst or abdominal swelling of any kind. After this he was sick once or twice, but on light diet he soon recovered, and was again able to leave the hospital on October 19, without any suggestion of pancreatic cyst.

On October 28 he walked into the out-patient department with very definite jaundice and an indefinite mass in the region of the gall-bladder. His mother stated that he had lost some weight, and there was no doubt that he was thinner. The jaundice was evidently obstructive, for the urine was loaded with bile, which was absent from the fæces. A diagnosis of probable rupture of the common bile-duct was made, and operation decided upon. Next day I opened the abdomen by an incision through the right rectus muscle. There was a little bile-stained fluid, but no blood in the peritoneum and no adhesions. The liver was a little enlarged but otherwise normal, though the gall-bladder and common duct were enormously distended. There was a good deal of œdema about the head of the pancreas, which was enlarged and hard. The condition was now looked upon as the result of contusion of the head of the pancreas, with inflammatory swelling and compression of the common bile-duct. The rest of the pancreas was exposed through the gastrocolic omentum, but there was no other evidence of gross injury, and no fat necrosis. After consideration, it was thought best simply to drain the gall-bladder, and this was accordingly done. The boy did very well. By November 7 there was some bile in the fæces and the jaundice was much less. By the 18th the bile stopped discharging, and on the 22nd he went home apparently quite well.

When the patient left the hospital I wrote the following comment on his case :

" I saw this boy at the time of his first admission, when there was some question of his being seriously injured. I decided that there was no serious abdominal injury because there was no rigidity and because the abdominal wall was contused, suggesting to me that the abdominal muscles were on their guard at the time of the accident.

However, the boy had evidently been seriously shocked, because the Sister of the ward, who has had great experience, was a little alarmed and was surprised that he picked up so soon. After a day or two he appeared quite well, and was allowed to go home. He was then re-admitted because of some pain in the upper abdomen, with vomiting, and because the doctor had noticed a mass in that region. I then expected to find traumatic effusion into the lesser sac of the peritoneum. When I saw him the next morning, all these symptoms had cleared up, and in the course of a day or two he appeared to be quite well. At the time of his third admission he looked thin and ill, and was very deeply jaundiced, and it was then that we diagnosed an injury to the bile-duct. At the operation there was no actual laceration of the gall-bladder or bile-duct, but there had evidently been a contusion either of the lower end of the bile-duct or the head of the pancreas, for there was a hard, indurated mass in this region, and the common bile-duct was very distended. We decided to drain the gall-bladder rather than make an anastomosis: first, because the condition was probably inflammatory secondary to the injury, and therefore likely to get spontaneously well; second, because a permanent anastomosis is not a desirable thing in such a young subject; and third, because an anastomosis could easily have been made if the treatment adopted had not proved satisfactory."

In the end of December, 1913, more than a year after the accident, this patient came to see me again. He was perfectly well and was working regularly as a telegraph boy; he had had no trouble since the time of the operation, and the urine was normal. The scar presented an extraordinary keloid condition, but it caused him no inconvenience, and was disappearing.

The explanation of this case appears to me fairly obvious. There had evidently been a contusion limited to the head of the gland, attended with hæmorrhage into its substance and with some bruising of the acini. As a result there would be a certain amount of inflammation, which would lead to so much swelling as to press on the pancreatic portion of the common bile-duct, thus accounting for the jaundice. Similarly, the late vomiting and distention of the stomach would be due to pressure of the enlarged head on the duodenum. Had this injury involved the tail of the pancreas, there would have been no troublesome after-effects, and the patient would probably have made a complete recovery without developing any symptoms directing attention to the pancreas.

The absence of rigidity was a striking and important feature in both cases. I always attach great importance to this symptom, and have usually felt that there is scarcely likely to be any serious injury in its absence. In all probability the rigidity was present, but only posteriorly, affecting especially the crura of the diaphragm, as my colleague Mr. Clay suggests, thus accounting for the cyanosis which was so marked a feature, and which has also frequently been noted in cases of acute pancreatitis.

Both cases show the need of extreme care in dealing with abdominal injuries, for it is clearly not enough to conclude that the injury will be unattended with serious after-effects because there are no signs of rupture of the hollow viscera or of hæmorrhage.

REFERENCES.

[1] *Northumb. and Durham Med. Jour.*, 1903, 188.
[2] *Brit. Med. Jour.*, 1892, ii, 1053.
[3] *Trans. Clin. Soc.*, xxxix, 63.
[4] Recent Experiences in the Surgery of the Liver and Gall-bladder, *Brit. Med. Jour.*, 1908, Jan. 4.

CASES OF ACUTE INTESTINAL OBSTRUCTION DUE TO RARE CAUSES.

By JOHN MARNOCH, Aberdeen.

The earlier diagnosis of acute intestinal obstruction, and a more general recognition that it is a disease remediable by surgical measures alone, have led to more perfect results in its treatment, and now a recovery after operation for acute obstruction is fortunately looked upon as far from exceptional. As regards the causes of the malady, some are common, while others are rare. It is probable, however, with our wider and more accurate knowledge of internal strangulation, that causes which were hitherto regarded as exceedingly rare will turn out to be not so uncommon. It is with the view of putting on record some of the rarer causes that the following cases are quoted, viz. :—

Case 1.—**Volvulus of the Cæcum.**

P. N., male, aged 67, was admitted under my care in the Aberdeen Royal Infirmary at 8 a.m. on January 6, 1911, suffering from acute abdominal pain, sickness, and vomiting. His history was that on January 1 he was seized with sickness attended by retching and vomiting. This passed off after a few hours, but he felt out of sorts for the next two days. On January 3 diarrhœa developed, and he had to stop work. This diarrhœa lasted for a couple of days and was accompanied by a recurrence of the vomiting. At 1 p.m. on January 5 the diarrhœa ceased, and from that time there was complete constipation and no passage of flatus, but the vomiting continued and was attended by pain. Soon after the cessation of the diarrhœa he noticed a little swelling on the right side of his abdomen, but stated that it varied in size at different times. On the following day (the day of his admission to hospital) he observed some general distention of the abdomen.

Condition on Admission.—Patient was of thin, spare habit, temperature 98°, pulse 70, respirations 22. He complained of abdominal pain, and was sick, and vomited bilious material. He referred his pain mostly to the right side of his abdomen, which moved well with respiration, and showed a slight amount of distention all over, but more marked on the right side than on the left. There was no rigidity, no sign of free fluid in the abdomen, and no hernia. When I saw him at 11.30 a.m. a considerable change had taken place in the appearance of the abdomen. There was now, in addition to a little general distention, a more marked localized swelling in the right lower quadrant about the size of a fœtal head, resonant on percussion, and quite soft on palpation. This marked increase in size had taken place almost wholly within seventy-five minutes.

Operation.—The abdomen was opened at 12 noon by a mesial incision below the umbilicus, and the cæcum found much distended, its diameter being about five inches. A closer examination showed that, along with a few inches of the adjacent ileum, it had undergone rotation through a complete half-circle. The appendix was found stretched tightly from its cæcal attachment upwards and inwards to the back wall of the abdomen, to which it was intimately adherent by its tip. Some bands of adhesions accompanied the appendix. On undoing the volvulus, it was found that a little above the ileocæcal junction, the point around which the cæcum and adjacent colon had rotated, and where the lumen had consequently become obliterated, the colon was partially bound down to the back of the abdomen by several bands of adhesions which ran transversely across it. The lumen, however, at this point, after the twist was undone, was quite patent, although narrowed. A mesentery was present, common to the lower ileum, cæcum, and ascending colon, as far as the bands

referred to. The cæcum did not empty itself, but remained distended after its position was rectified, and accordingly it was punctured by a trocar and cannula, a considerable quantity of gas and some liquid escaping. The puncture was sealed up by suture. The appendix was then removed, and the partially-constricting bands over the colon divided. The abdomen was then closed.

The patient's recovery was uneventful.

Remarks.—The probable sequence of events in this case was that the sickness and vomiting on January 1 were due to some indiscretion in eating or drinking, not unusual at the time of the year, and that the consequent diarrhœa was due to the same cause. The mechanical factors concerned in producing the volvulus, during the course of the diarrhœa, were probably fermentation in the cæcum, leading to its distention, the presence of a mesentery common to the ileum, cæcum and lower part of the ascending colon allowing abnormal mobility, and the adherent appendix, which caused the distending cæcum to rotate more and more upwards and inwards round the point in the ascending colon fixed by adhesions, until finally the volvulus and obstruction were complete. It is possible that the initial symptoms were due to an attempt at volvulus on the part of the cæcum, and that this rectified itself, only to recur and go on to complete obstruction during the attack of diarrhœa. The absence of pain at the onset of the illness is, however, rather against this. Corner and Sargent[1] in a review of fifty-seven cases collected from literature, including six of their own, found that a considerable proportion of these had a history of previous attacks of pain in the cæcal region with obstructive symptoms, and that the duration of symptoms in some of the cases submitted to operation was often considerable. They therefore conclude that cæcal volvulus may be acute, subacute, or chronic. In the case given above, the symptoms were distinctly acute; moreover, a careful inquiry into the man's previous history failed to elicit any illness whatever which would fit previous attacks of rotation. Indeed, the only illness which he would confess to was an attack of "inflammation of the kidneys" which occurred when he was 8 years of age. So far as he could remember, he had abdominal pain with the illness. Possibly this was an appendicitis. Certainly, the changes in the appendix and right iliac region pointed to his having had trouble with that organ at some time or other. The occurrence of volvulus as a cause of intestinal obstruction is uncommon, while volvulus of the cæcum is distinctly rare. Eckehorn[2] was able to collect 92 cases of cæcal volvulus, and quotes Faltin as stating that in Finland 27 per cent of all cases of volvulus affected the cæcum. The point in the diagnosis which is worth noting, and which was very pronounced in this case, is the local meteorism, and it appears from a study of reported cases that the less the involvement of the small intestine, the more prominent is this symptom.

Case 2.—**Repeated operation for obstructive attacks due to congenital abdominal abnormalities.**

J. H., a feeble-minded lad, 17 years of age, was admitted to my ward in the Aberdeen Royal Infirmary on November 30, 1906, with a history of having been suddenly seized with acute abdominal pain on November 25. On the following day his symptoms abated somewhat, and he was able to work until the afternoon, when the pain became so severe that he had to desist and go home. From this time onwards to his admission to hospital the abdominal pain was continuous, but subject to severe exacerbations. Vomiting commenced on November 27, and was repeated at frequent intervals. The vomit was bilious in character, and so far no fæcal odour had been noticed about it. There was absolute constipation, both as regards

fæces and flatus, from the 25th, although on one occasion an enema had brought away one or two small scybala.

Condition on admission.—Temperature 97·2°, pulse 80, respirations 22. He lay on his back, crying out at intervals with pain, and expressing a frequent desire to go to stool. There was well-marked fullness and pulsation in the epigastric region; otherwise nothing abnormal could be detected. No hernia was present.

Operation.—The abdomen was opened on November 30 at 1·15 p.m. through a mesial incision below the umbilicus. A couple of coils of small intestine presented, but no trace of the rest of the small bowel was at first visible. The cæcum was searched for, and the ileum traced from this. It ran directly upwards to the upper abdomen through what appeared to be an aperture leading up behind the stomach. The bowel was only very moderately compressed at this aperture, and practically the whole of the small intestine was delivered from its retrogastric situation. From the neighbourhood of the aperture referred to, a band of tissue ran downwards towards the left side of the pelvis, compressing the sigmoid flexure in its course. This was divided between two forceps and the sigmoid released. His bowels acted regularly after operation, and he was discharged well on December 26.

A fortnight after his discharge the patient was readmitted with a left strangulated hernia of about twenty-four hours' duration. This was relieved by operation, the sac being found to be a patent processus vaginalis, and his recovery was uninterrupted.

He appears to have remained fairly well until July, 1910. He then began to suffer from heartburn and attacks of vomiting. These attacks were preceded by the eructation of a mouthful of sour, watery material, only occasionally by nausea. The vomiting took place at intervals, the quantity brought up being frequently large, and consisting mainly of food he had eaten. There was never hæmatemesis. His bowels were constipated during the attacks.

Condition on Admission.—He was rather poorly nourished, and complained of some discomfort in his abdomen prior to vomiting. No tenderness or abnormality could be made out by percussion or palpation. Inflation of the stomach, and screen examinations after a bismuth meal, failed to demonstrate any dilatation. The vomit consisted of food particles, and contained abundant free HCl.

Operation.—On April 29, 1911, in view of his previous history, an exploratory incision was made in the epigastric region through the right rectus muscle. The stomach was found perfectly free and unattached to the colon, the omentum being represented by a ragged fringe, on an average two inches long, hanging from the greater curvature. There was therefore no lesser peritoneal sac. Two bands of omental-looking tissue arose from the greater curvature at a point near the cardiac end, and ran downwards to the left and right respectively. In order to investigate the course of these bands, as also to explore the situation of the large intestine, which was not visible in the wound, the abdominal incision was enlarged freely downwards. The bands referred to were found attached, one to the left iliac fossa on the inner aspect of the mesosigmoid, the other to the right iliac fossa near the brim of the pelvis. Both bands were fairly tight, and not connected with anything between their points of attachment. They were completely removed. The duodenum, which was loosely covered by peritoneum, had no transverse part, but ran straight into the jejunum, well to the right of the spine. The peritoneum covering the terminal few inches of the ileum had lost its gloss considerably, and appeared somewhat cicatricial. From the posterior part of the pylorus, and connected with the gastrohepatic omentum at that region, there stretched another band of omental-looking tissue about two inches broad and very vascular, down to the right iliac region behind, very much where one of the bands arising from the stomach was attached. This also was removed. The large intestine, from the cæcum to the upper part of the rectum, was possessed of a mesentery at least a foot long, and was free to roam about the peritoneal cavity. The appendix contained a concretion and was removed, and in order to limit the excursions of the large intestine, a part of it, which was taken to correspond to the transverse colon,

was stitched to the greater curvature of the stomach. Any further attempt to anchor the large gut to the parietes was abandoned, as it became evident that kinking would more readily occur if this were done. The other abdominal organs appeared to be normal. His recovery was uneventful and he was discharged well.

Remarks.—The explanation of this patient's symptoms became readily apparent in view of the abnormalities present. All three bands were fairly tight, especially the one stretching from the pyloric region. Kinking of the intestine, especially by the stomach bands, must have been exceedingly easy, and evidently this occurred repeatedly. At the first operation, when he was suffering from acute obstruction, the state of affairs within the abdomen was not properly appreciated, and indeed was misinterpreted, the exploratory incision being small. It was not until the discovery of the abnormal condition of the stomach, and the subsequent investigation of the other abdominal organs through the larger incision of the last operation, that the cause of the acute attack became evident. The small intestine had evidently slipped behind the pyloric band and passed transversely across behind the stomach. The band itself was tight, and lay in close contact with the posterior abdominal wall, and was capable of compressing the afferent and efferent loops. The bands from their structure were clearly not inflammatory in origin. A perusal of the literature at my command has failed to find a similar condition of affairs reported. Cases in which the large intestine, in whole or in part, is possessed of a mesentery, are found occasionally, but such an assemblage of abnormalities must be far from common.

Case 3.—**Intersigmoid Hernia.**

W. F., male, aged 62, was taken suddenly ill about 1 a.m. on June 21, 1911, with a gnawing abdominal pain of a paroxysmal character, situated below the umbilicus, but rather more to the left than to the right side. According to his own statement, he had been in excellent health prior to this, although he suffered from constipation; but some of his relatives were of opinion that he had been losing flesh for several months past. His illness was thought to be due to an indiscretion in diet of the previous evening, and a dose of castor oil was administered, but without any result. An enema was equally unsuccessful in getting his bowels to move. Meanwhile his pain continued, and on the morning of June 22, another attempt was made by enema to procure an action of the bowels. On this occasion some fæces came away, but no flatus. He now began to vomit bilious-looking material, and this went on at intervals until evening, when again an enema was administered and again some fæces were passed. This had the effect of relieving him somewhat, the vomiting ceased, and he expressed himself as more comfortable. Early in the morning of the 23rd, vomiting again began, and was frequent during the course of the day, the vomitus now being darker in colour. Late in the evening I was summoned to see him, and reached his residence about midnight. He looked ill, and his pulse was somewhat feeble. He complained of sickness and vomiting and a diffuse abdominal pain, although this was more intense on the left side. The vomit was greenish-brown, but devoid of fæcal odour. The abdomen was moderately distended.

Operation.—June 24, 1911, at 1 a.m. It was clear that he was suffering from acute intestinal obstruction; but whether it was grafted on to a chronic obstruction was not quite clear from the history obtained. In view of the brunt of his pain being referred more to the left side, the abdomen was opened through the left rectus muscle. Some blood-stained fluid escaped from the peritoneal cavity. The small intestine was distended and congested, while the cæcum was collapsed. Owing to this distention, it was found difficult to make out the site of obstruction, and accordingly the small intestine was allowed to prolapse into warm sterile towels. A clear view was then obtained of the state of affairs. A knuckle of ileum, not far from the ileocæcal junction

and about 5 inches long, had become ensnared in the intersigmoid fossa on the back wall of the abdomen, on the left side over the inner margin of the psoas at the attachment of the mesosigmoid. The strangulated gut was not difficult to deliver, and although deeply congested it appeared viable. The mouth of the pocket looked downwards and slightly inwards, and easily admitted the index finger for a distance of about 3 inches. A small incision was made into one of the distended coils above the obstruction, and a large quantity of highly offensive fluid drawn off, after which the incision was sutured and the abdomen closed.

An hour or two after operation, he became very restless and delirious, and could be kept in bed only with difficulty. At mid-day, during one of his attempts to get up, he fell back suddenly and expired.

Remarks.—The main interest of this case is its extreme rarity. We are indebted to Moynihan[3] for a masterly account of the anatomy and surgery of the peritoneal fossæ. According to this authority, the intersigmoid fossa is invariably present in the fœtus and infant, but decreases in frequency with age. In a number of bodies examined, of different ages, he found the fossa present in 70 per cent. In spite of the frequent persistence of the fossa, a hernia into it seems to be exceedingly uncommon, for Moynihan was able to find recorded only two authentic cases, one by Eve and another by McAdam Eccles. Coley[4] records another case which he met with in a child who died with symptoms of obstruction a few days after birth. Another case recorded by Lambert was rejected by Moynihan, as he was unable to consult the original description, but Coley has been able to establish its authenticity. My own case makes a fifth. So far, no case of intersigmoid hernia has recovered, mainly from the fact that they were late in being dealt with; but there is no reason why an intersigmoid hernia should prove fatal any more than any other form of internal strangulation, provided it is submitted to timely operation.

Case 4.—**Hernia into the paraduodenal fossa.**

H. C., a married woman of 46 years of age, was admitted to the Royal Infirmary, Aberdeen, on October 7, 1913. Since 1900 she had been liable to acute attacks of abdominal pain and vomiting, lasting from one and a half to four and a half hours, the intervals between the seizures being on an average three months. She stated that for the last few years she had suffered from "indigestion." There was no history of periods of constipation. Her pain was always referred to the same situation, viz., the lower epigastric region, from which it radiated transversely across the abdomen up to both shoulder-blades and down to the loins. She had never had jaundice nor any urinary trouble. She had an attack a fortnight prior to admission, which recurred on October 3, and again on October 5. The last attack persisted without abating in severity, and she had passed neither fæces nor flatus since its onset.

Condition on Admission.—She was a stout, healthy-looking woman, and complained of acute pain in the regions referred to. Her abdomen was perhaps slightly distended in the umbilical region, but there was no visible peristalsis and no area of abnormal dullness. Some tenderness was elicited in the epigastric and right hypochondriac regions, but no tumour was palpable. No hernia could be detected over any of the usual sites, and the vaginal and rectal examinations revealed nothing abnormal. Her temperature was 98°, pulse 96, and respirations 26. A provisional diagnosis of biliary colic was made; but as an acute obstruction could not be negatived it was decided to operate without delay.

Operation.—This was done at 8.30 p.m. on the evening of admission. The abdomen was opened through the right rectus muscle, the centre of the incision being opposite the umbilicus, and a quantity of blood-stained inodorous fluid escaped. Coils of distended and congested small intestine presented themselves, and on following the bowel there were found small subperitoneal hæmorrhages in its wall and mesentery, becoming more numerous as the site of obstruction was reached. This proved to be

a paraduodenal fossa. A loop of jejunum, about its middle, had entered the fossa and become strangulated. On delivering it—a procedure which offered no difficulty—this loop was found to be about three feet long, and at its point of exit from the fossa, where it turned sharply over the edge of the crescentic ring, it was distinctly narrowed. This constriction had a cicatricial appearance and was evidently not due to recent compression. It was, however, not so narrow as to demand any plastic operation. On introducing a couple of fingers upwards into the fossa, which could be done easily, a cavity of considerable dimensions could be made out. It lay to the left of the spine, and ran upwards and rather outwards from the orifice. A couple of stitches inserted into the margins of the crescent made it fit comfortably round the duodenal-jejunal flexure and closed the mouth of the sac. The inferior mesenteric vein lay near, but not quite at, the margin, so that the stitches could be placed with a fair bite without interfering with the vessel. The stomach, gall-bladder, and appendix were normal. The abdomen was thereafter closed.

The patient's convalescence was quite smooth, the bowels being freely moved by enema on the day after operation. She was discharged well on October 22.

Remarks.—Duodenal hernia, which may be either right or left, is far from frequent ; but the latter, of which this is an excellent example, is the commoner. It is seldom that it becomes strangulated or produces very acute symptoms during life, and consequently most of the reported cases have been found post mortem, in patients dying of other diseases. Moynihan in 1899 collected 57 cases, and a few have been added since. The sac varies much in size. It may contain a very small knuckle of bowel, or practically the whole small intestine.

The symptoms are very variable ; but this case illustrates well what has been found in a certain proportion, viz., a history of attacks of colic and dyspeptic symptoms. The explanation is not far to seek, and is well exemplified in the case of this woman. The cicatricial narrowing of the bowel and the easy entrance into the fossa, taken in conjunction with the history, renders it almost certain that part of the small intestine had for long reposed in the paraduodenal fossa, and that variations in the size of the hernia account for her indigestion and periodic attacks of pain and vomiting. Evidently more of the gut had entered than the fossa could well accommodate, and hence the strangulation.

The diagnosis of the condition may be made with some degree of probability where the hernia is large. It rests on symptoms of obstruction combined with the presence of a resonant tumour either in the upper left or upper right abdomen, presenting gurgling on auscultation, and retraction of the area corresponding to the colon. In the above case, the length of incarcerated bowel was not great, and the obesity of the patient masked what local fullness might have been present.

Coley[5] collected 10 cases successfully operated upon, 9 of left and 1 of right duodenal hernia. The problem of how to deal with the orifice and sac so as to prevent recurrence has received little consideration on account of the rarity of the condition, but it obviously presents marked anatomical difficulties.

I am indebted to Dr. A. W. Falconer for searching some of the literature bearing on the above cases.

REFERENCES.

[1] *Ann. of Surg.*, 1905, i, 63.
[2] *Archiv. f. klin. Chir.* 1904, 572.
[3] *Brit. Med. Jour.*, 1899, i, 657.
[4] *Ann. of Surg.*, 1909, ii, 238.
[5] *Keen's Surgery*, iv, 102.

LOOSE BODIES IN THE KNEE: WITH SPECIAL REFERENCE TO THEIR ETIOLOGY AND GROWTH.

By R. H. ANGLIN WHITELOCKE, Oxford.

The so-called loose bodies are anatomically of two varieties, according as they are completely detached and freely moveable from one part of a joint to another, or as they are moored or tied down in a particular part, with limited range of movement. They have been of interest to surgeons for many years, and whilst present-day views are still at variance as to their precise origin and significance, all or most are agreed as to their clinical features and treatment. Towards the end of the eighteenth century—John Hunter died in 1793—we have a record by Sir Everard Home, Hunter's brother-in-law, published at that time in the "Transactions of a Society for the Improvement of Medical and Surgical Knowledge,"[1] and quoted by D'Arcy Power (Hunterian Lecture),[2] that Hunter

Fig. 438.—(*a*) Portion of detached semilunar cartilage in knee. (*b*) Portion of synovial membrane from same joint (plica synovialis patellaris) showing thickening and early papillation. (*c*) Pedunculated cartilaginous body adhering to synovial membrane of same joint.

had been experimenting and making observations concerning the etiology of these structures. Hunter's pathology seems to have been at fault, for he not only believed, but taught, that these cartilaginous bodies were the result of changes which followed upon the extravasation of blood. Hunter, in his wish to establish a new "principle in the blood," maintained that blood, when effused, tended to organize and to adapt itself to the tissue in which it was effused; so that if the effusion were in the abdomen a soft tumour resulted, or if in the neighbourhood of bone, a hard one. In the knee, he thought that the organized clot attached itself to the articular cartilage, assumed its character, and later, becoming detached, gave rise to loose cartilaginous bodies.

Hunter's teaching in this respect seems to have been discredited a few years

later by the investigations of George Rainey of St. Thomas's Hospital (1801–1804), who, with improved methods and instruments, established the more modern and true pathology.

Loose bodies in the knee, as in other joints, are formed as the result of (1) *Diseased conditions*; (2) *Injury*.

This classification is convenient for the purpose of this paper, as showing more clearly how the attempt is made to draw a comparison concerning the diagnosis, prognosis, and treatment of the two classes.

Although authorities differ as to the precise views expressed regarding the exact etiology of some of the forms, there is general agreement as to the main

FIG. 439.—Loose cartilaginous body partially embedded in the articular cartilage of the femoral condyle.

principles of the above classification. It becomes necessary, therefore, in dealing with the subject in hand, to consider both varieties of loose bodies, whether they are of pathological and constitutional significance in the main, or are of a more local and traumatic nature and origin. Those which are the result of injury will receive most attention, and they will be compared and contrasted with the others as they approach or diverge from them in their life-history and results.

Another classification which is sometimes utilized is that which concerns the minute structure of the bodies, so that they are grouped into (1) *Fibrinous loose bodies*; and (2) *Bodies composed of organized connective tissue.*

1. FIBRINOUS LOOSE BODIES (CORPORA ORYZOIDEA) (KÖNIG).

These are nearly always the result of constitutional disease, with the single exception of certain rare cases of traumatic nature, in which foreign bodies, such as the points of needles accidentally introduced into the joint, become enwrapped or ensheathed by concentric layers of coagulated fibrin. The true fibrinous bodies, differing from those in the exceptional cases just related, are formed either of homogeneous or concentrically laminated masses of fibrin. They vary in size and shape, and have been variously described as melon-seed, rice-grain, and wafer bodies. They may be of almost any shape; we even see pencil-shaped strips of fibrin, free or adhering to the synovial membrane. Their varying shapes and smooth, polished surfaces are caused by friction during the movements of the joint. They may be numerous or few, are usually small, but have been described sometimes as solitary and large. They are not peculiar to joints, but are to be found in tendon-sheaths and enlarged bursæ, whether these communicate directly with, or are completely separated from, a joint-cavity. They are more frequently seen in the smaller articulations than in the knee, and it is believed that they are always formed from a degeneration of the synovial membrane. They may be found in arthritis deformans, Charcot's disease, and synovial tuberculosis, and when they are present, there is almost always superadded chronic synovial effusion of varying quantity into the capsule. They are regarded as the result of fibrin-coagulation on the surface of a diseased synovial membrane; and in some cases of tuberculous hydrops, as the result of a fibrinous degeneration of the surface-layer of the synovial membrane. Clinically, they differ from other forms by never producing locking in the joint,

FIG. 440.—Lipoma arborescens from early case of osteo-arthritis in man, aged 42, result of chronic traumatic synovitis.

FIG. 441.—Lipoma arborescens from early Charcot's knee, with history of previous injury.

FIG. 442.—Lipoma arborescens from plica alaris (medialis).

the outstanding classical symptom so characteristic of these bodies as a rule; they are usually recognized by the crepitating sensation imparted to the examining hand or fingers as they move one upon another in the synovial effusion during the passive movements of the joint. Their true nature is often first suspected owing to the existence elsewhere in the body of other symptoms of the disease,—one in which they themselves play such a significant part in the knee.

The treatment should be directed mainly towards the constitutional disease, and if any local treatment becomes necessary, evacuation by means of incision is the simplest and safest.

2. BODIES COMPOSED OF ORGANIZED CONNECTIVE TISSUE.

Organized bodies as the result of disease.—These bodies are found as the result of disease as well as of trauma. In certain forms of chronic synovitis, supervening on one or other form of osteo-arthritis, Charcot's arthropathy, or repeated and intermittent traumatism, the synovial membrane becomes swollen, œdematous and thickened. Especially is this thickening to be seen in such situations as those where the membrane is naturally folded upon itself, or where it ends in free folds or fringes. As the result of chronic irritation the folds become thickened; the cellular and fibrous elements increase sometimes by a process of true new growth, at other times mainly by addition to the inflammatory exudation products. The articular surface of the synovial membrane becomes roughened and papillated, so that instead of perfectly smooth movements (*Fig.* 438 *a*, *b*, *c*), a rough friction is engendered during the normal movements of the joint. All this is productive of more irritation and more synovitis, and moving thus in a vicious circle, the process goes on until, by increased and repeated irritation, the fibrous elements pass on to cartilaginous, and even bony, formation. Nor is this development of fibrous tissue into cartilage surprising if we recall the fact for a moment that the early development of the synovial membrane, and of the articular and inter-articular

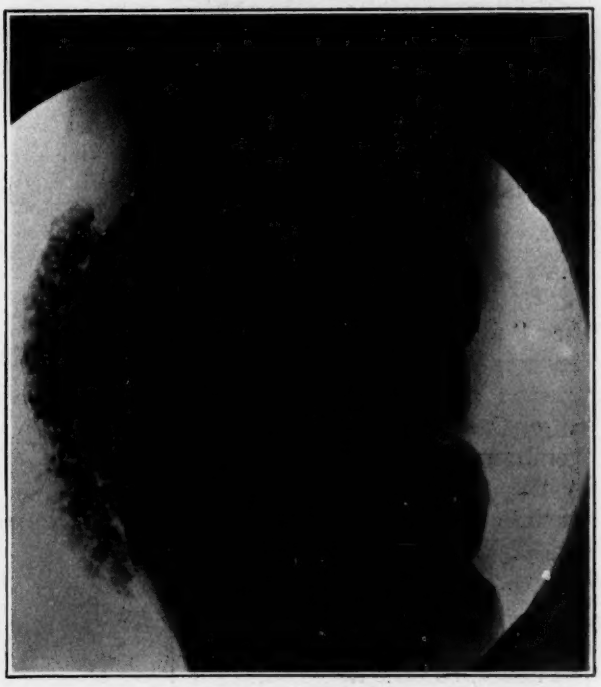


FIG. 443.—Ecchondromata in a neuropathic joint with osteo-arthritis. (*Lent by Mr. Robert Jones.*)

cartilages of the joint, is all from the same primitive undifferentiated embryonic intermediate layer of the axial blastema. Certain of the papillæ on the free surface of the synovial membrane and on its free edges—probably those most exposed to irritation—tend to increase in size and to become pedunculated, as do warty growths on other free surfaces. From time to time these outgrowths are liable to be caught and bruised, even during the ordinary movements in the articulation, so that they grow, and increasing in size, later on become more and more pedunculated, until finally, during some forcible movement, they are nipped between the bones, torn off and completely detached, either to wander freely as the "Gelenkmaus" of the German writers, or to be entrapped and steadied in some out-of-the-way pocket of the membrane, or to lie peacefully in the neighbourhood of the cruciate ligaments in the intercondyloid space of the femur. On rare occasions they are localized and fixed by the accident of being pressed between the bones, so that they eventually lie snugly, partially embedded (*Fig.* 439) in a fossa in the articular cartilage of one or other condyle of the femur, usually the medial, and may require enucleation thence during the operation for their removal.

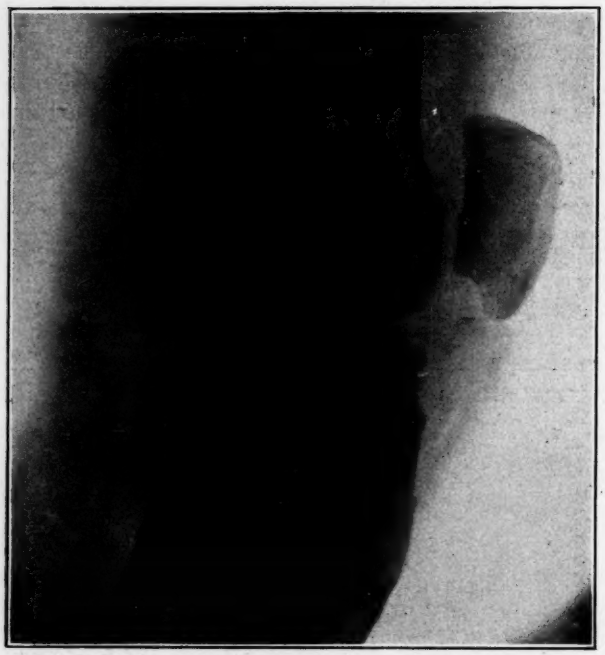


FIG. 444.—Bony nodules in a case of Charcot's disease—neuropathic osteo-arthritis. Mr. Richardson's case. (*Lent by Mr. Rutherford Morison.*)

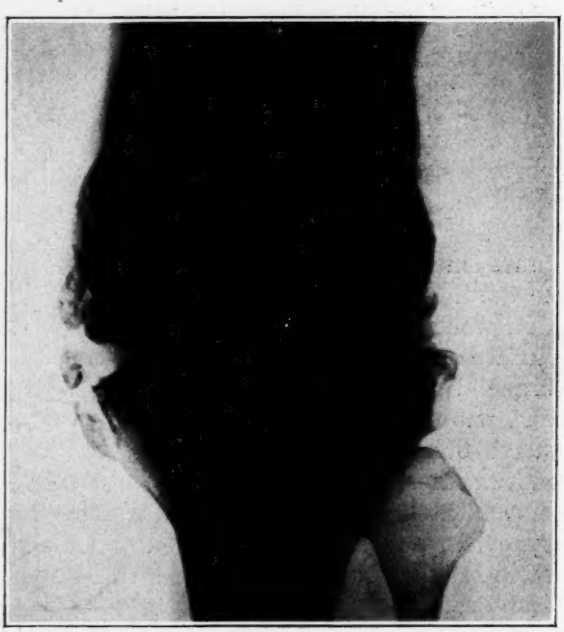


FIG. 445.—Bony deposition in the tibial collateral ligament, from a case of Charcot's disease—osteo-arthritis.

In osteo-arthritis and Charcot's disease, we may

occasionally find fat instead of cartilage developing in the synovial fringes. The deposition of fat in the synovial membrane may be so great as to almost fill the joint and limit its movement considerably. The condition is known as

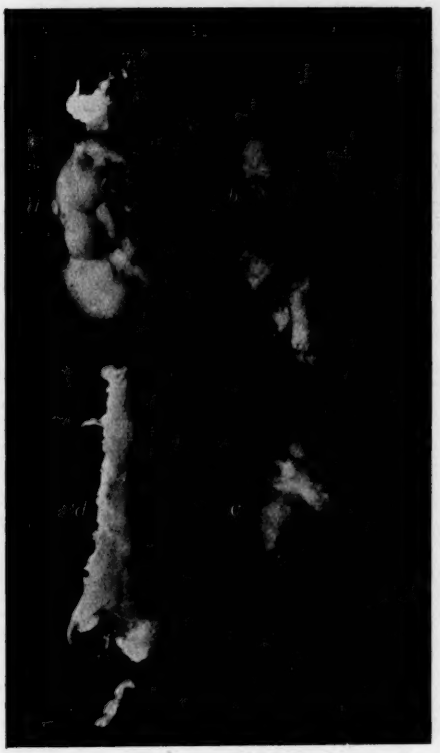


FIG. 446.—Bodies formed as result of chronic synovitis; (*a*) partly cartilage and partly fat; (*b* and *c*) hyaline cartilage; (*d*) fibrous tissue.

FIG. 447.—Bodies taken from a joint, the result of organization of clot after constant bruising of meniscus.

lipoma arborescens (*Figs.* 440, 441 and 442). In addition to the lipomata and the pedunculated loose cartilage-bodies formed in the synovial membrane, we may have ecchondromata (*Fig.* 443) and small bony growths developing in osteo-arthritic and neuropathic joints as the result of lipping at the edges of the articular surfaces. These last, as the effect of an injury, may be detached and become free in the joint. In Charcot's disease, bony nodules and plaques may also form in the capsule and other ligaments, and then grate one upon the other (*Figs.* 444 and 445).

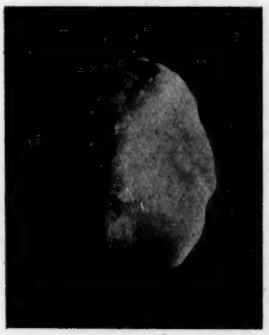


FIG. 448.—Bone detached from under surface of patella by blow years before removal, showing growth of cartilage over its surface.

The clinical features are, in the main, those of the constitutional disease which predisposes to the loose bodies. They are rarely met with in practice.

Treatment consists of removal, when it is necessary to relieve pain or restore movement.

Organized bodies as the result of injury in more or less *healthy* joints are of various kinds. The following are some of the varieties:—

1. Loose bodies either of fibrous tissue, hyaline cartilage, fat or bone, developed as the result of chronic irritation of the synovial membrane (synovitis) (*Figs.* 438 and 446).

2. Loose bodies following upon contusions or lacerations of the synovial membrane, where the fibrinous clot undergoes organization, develops cartilage or bone, and becomes pedunculated and even detached (*Fig.* 447).

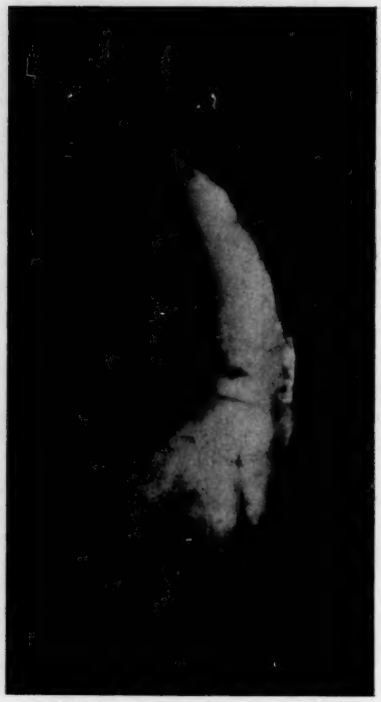


FIG. 449.—Complete detachment of medial meniscus from knee of sailor who fell into a hold, and on whom amputation above knee was performed.

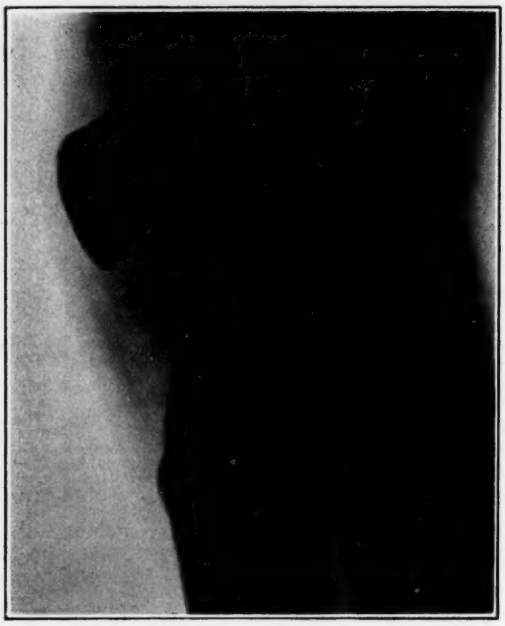


FIG. 451.—Portion of point of a compass which entered knee accidentally and remained *in situ* 14 years.

FIG. 450.—Partial separation of body from torn medial meniscus, removed from the knee by operation.

3. Portions of the articular cartilage which become separated from the femur, patella, or tibia, as the result of a direct blow, or more rarely from a severe twist or strain, being detached with a ligament (fracture-sprain) (*Fig.* 448).

4. Portions of one or other semilunar fibrocartilage (meniscus), detached either completely (rare) (*Fig.* 449), or partially (more usual) (*Fig.* 450).

5. Foreign bodies introduced purposely or accidentally (*Fig.* 451).

1. *Loose bodies arising from chronic irritation of the synovial membrane.*

It is in this group of cases that the classical symptoms calling for the surgeon's intervention are

most frequently met with, and although they affect other joints, such as the elbow, the knee is pre-eminently their seat of election. They occur mostly in males under thirty years, by reason of their greater liability to accidents, though athletic and active women are by no means exempt.

Perhaps the commonest variety is that which is developed as the result of chronic traumatic synovial irritation. In old-standing cases of torn and partially detached semilunar cartilages (menisci), especially in individuals over the age of 30 or of middle age, where there are repeated attacks of synovitis, it is by no means uncommon to find the synovial surface roughened and studded with minute papillated outgrowths (*Fig.* 438 *b*), so that the membrane in the earliest stages presents the appearance of rough velvet pile to the naked eye. If the mechanical irritation is continued, the synovial fringes become thickened and lobulated, and in the later stages, certain portions (those most likely to be caught between the bones in flexion and extension of the joint) develop nodes of hyaline cartilage in their substance, become pedunculated (*Fig.* 438 *c*), and as they grow larger become continually freer until, with some violent and unexpected movement, one or more of them become detached.

The increased growth begins usually near the site of the original injury, but the process may eventually spread over the whole surface of the synovial membrane until the bodies number dozens or even hundreds. Once the condition is started, it seems to be progressive unless means are taken to prevent the chronic irritation of the synovial membrane.

The symptoms in these cases vary. In one, the complaint may be of vague pains attributed to chronic rheumatism, or of occasional cracking or creaking in the joint even during ordinary work, or in some simple movement as in rising after resting. There may be impairment of function, such as inability to extend the leg rapidly or fully, or to flex it completely. In other cases, and perhaps in the largest number, a distinct account is given of some sudden and unexpected, even sickening, pain, experienced after a simple movement such as turning in bed; this leads to disability and locking, so that the limb cannot be completely straightened, though flexion is usually effective and painless. These symptoms are rapidly followed by swelling and other signs of overstretching and straining of the ligaments of the joint. The loose body may be disengaged, the locking may be as easily undone, and recovery takes place as after a sprain. For many years, at irregular and unexpected times, the individual may suffer similar attacks.

When such a joint is examined it is usually enlarged, often full of fluid, and may be tender in certain places, notably over the condylar attachments of the internal and external lateral ligaments (tibial and fibular collateral), and over all the attachments of the posterior ligament. The surgeon or the patient may be able to feel the body as it lies in one or other pocket of the membrane, on one or other side of the patella, in front of the collateral ligaments, or in the suprapatellar pouch. Not infrequently the patient has been able to satisfy himself of the presence of the stranger, and may be able to demonstrate its position and peculiarities, and to give an account as to whether it is moored at one point, or is subject when completely free to extensive and varied wanderings.

A skiagram is very helpful in deciding and localizing the presence of a loose body when it contains a bony deposit, although it gives no true estimate as

to its size. As patients nearly always state or believe that the disability is due to an injury, it behoves the surgeon always to be on his guard lest he overlook a possible constitutional cause or complication.

Treatment consists in arthrotomy, with complete exploration of the synovial cavity, for it is by no means unlikely, unless all the pockets are examined in detail, that a body or bodies may escape detection and be left behind. Such an experience has befallen the writer in a case in which a torn semilunar cartilage had been removed, whilst a loose body was left undetected.

2. *Loose bodies arising from contusion or laceration of the synovial membrane,* with organization of a fibrin clot, followed by the development of a pedunculated, fibrous, or cartilaginous body.

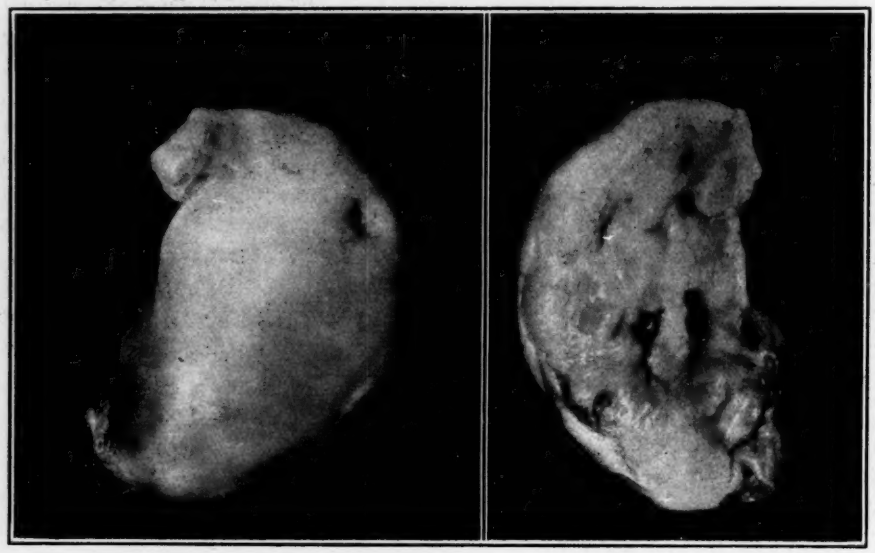


FIG. 452.—Loose body containing cartilage and bone, removed from knee-joint as the result of injury. Shows hyaline cartilage grown over the fractured surface. (*Lent by Mr. Rutherford Morison.*) Considerably magnified.

This is a rare variety, but it has been described by some competent clinicians. The present writer is in agreement as to the etiology of this group, and is satisfied that he has procured at least two specimens (*Fig.* 447) which bear out this description with fair accuracy. The symptoms, diagnosis, prognosis and treatment are the same as for the other forms found in healthy joints.

3. *Loose bodies due to the detachment of portions of articular cartilage:* by direct violence, such as a blow (*Fig.* 452), or indirectly from detachment with a ligament in severe sprains (fracture-sprains) (*Fig.* 453).

This is an important group, and the characters are remarkably constant. The bodies are usually solitary, as their etiology explains; they vary from the size of a horse-bean to that of a large almond, and are plano-convex or concavo-convex in shape, the convex aspect being perfectly smooth, while the plane or concave surface is uneven, roughened, or nodular (*Fig.* 454). They may be free, or movable from side to side, or from one part of the joint to another, but not

infrequently are fixed in a fossa or excavation in the articular surface of one or other femoral condyle; occasionally they are found in the inter-condylar space in close relation to the cruciate ligaments, from which situation they may require dislodgement at the time of operation.

When carefully examined, these bodies will be found to be covered for the most part with a thick, shining, white layer of hyaline (articular) cartilage, whilst on the smaller plane or concave side there will often be noticed a thin plate or plaque of true spongy bone. For many years they have been described as solitary, and to possess the peculiar concavo-convex or plano-convex shape; but the present writer has never met with a satisfactory explanation of these specific features in the writings of others. He desires in this article to give, with the aid of a series of photographs of specimens removed by operation, the true explanation of their usual solitude and of their distinctive shape. This series, if viewed closely, will go far to explain the process of evolution and growth of these bodies. Without a doubt all these specimens represent detached portions of *articular cartilage*, presenting on the one side the pearly-white, convex, hyaline, cartilaginous surface, and on the other the roughened and partially covered-over bony surface. When the articular cartilage is detached, as in *Fig.* 454, from the under surface of the patella, or when it is examined soon after the injury, the explanation is simple.

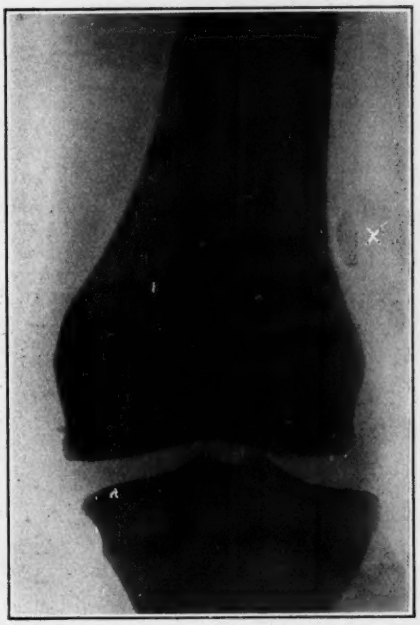


FIG. 453.—Loose body in knee (X) in a case of severe fracture-sprain with rupture of both cruciate ligaments and partial lateral luxation of the knee. The stranger was pulled off from the medial femoral condyle near the attachment of the posterior cruciate ligament, and wandered about freely in the joint.

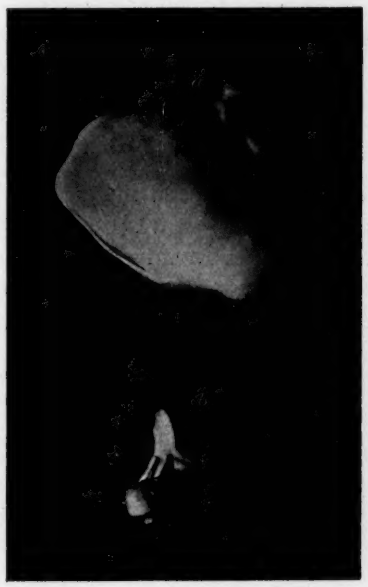


FIG. 454.—(*a*) Solitary concavo-convex body composed of bone and hyaline cartilage, detached from articular surface of patella; from its edge were growing two polypi. (*b*) Cartilaginous body from intercondyloid space, removed by operation.

The subject of the specimen (*Fig.* 454) met with a hunting accident in which his horse, in bolting with him through a gateway, knocked his patella violently against an upright post, so that he suffered from severe contusion with

hæmarthrosis of the joint. No skiagram of the limb was procurable, and the assumption was that the injury was contusion, not fracture. He suffered from a stiff knee for months after, though he was able to hunt during some weeks in the following season. He had always, however, to be helped to his saddle, for whenever he put his foot into the stirrup and tried to swing himself into his seat, he experienced a severe pain at the back of the joint. Sometimes effusion into the joint followed this movement. Later on he was persuaded to consult an irregular practitioner of much repute and fashion in London, who told him that he had a "bone out," and needed manipulations of the limb. These manipulations were tried, with the result that the symptoms were aggravated, chronic synovitis supervened, and he became very lame. The patient then came to the writer who, finding the joint much swollen, painful, and weak, had a skiagram taken. The Röntgen-ray examination proved negative, and as the symptoms were characteristic of *no one definite condition*, but rather gave the impression of something finding its way between the bones, though only after very specialized movements, as in passing from acute flexion to extension with weight upon the foot, it was thought advisable to make an exploratory examination. Consent was readily obtained, and an exploratory arthrotomy was performed through a long vertical incision to the inner side of the patella. After full lateral retraction of the patella and its ligament, the inter-condylar space was viewed and palpated. A low, flattened projection was to be felt on the lateral and under surface of the medial femoral condyle. In each movement of flexion and extension the projection touched the edge of the posterior cruciate ligament. The body (*Fig.* 454) was easily dislodged and removed from its new situation with an elevator. On further everting and examining the under surface of the patella, a correspondingly roughened surface could there be seen and felt. When the specimen is examined, it is seen that—although it lay fixed for some weeks in the femoral sulcus—the roughened part where it was detached from the patella has become completely covered in by a layer of hyaline cartilage. The corresponding surface of the patella had also been entirely covered over with hyaline cartilage, and was becoming, in the process of time, smoothly polished by friction. At the torn edge of the patella there were two small cartilaginous outgrowths like fringes, which also required removal. Thus, in a very few months the denuded and injured articular surfaces of both bones had become covered over by smooth, white, hyaline cartilage, which grew over them from the edges. This is an example of direct-blow fracture from concussion.

Fig. 453 represents the specimen taken in February, 1913, at the Radcliffe Infirmary, Oxford, from a youth, who in November, 1912, while running after a horse in a field, put his foot into a hole and so wrenched his knee that he suffered a rupture of both cruciate ligaments. He was sent to me because it was said that his knee was weak, and that he suffered from relapsing attacks of synovitis. Coming with the history of violent injury, followed by recurring attacks of synovitis with pain, and of something like partial locking, it was thought advisable to take a skiagram (*Fig.* 453). This clearly showed a small shadow, presumably of bone, movable in the supra-patellar pouch, and an irregularity of the whole articular outlines indicative of partial luxation. The joint was opened, and there was found, as expected, a laceration of both cruciate ligaments, and a portion of articular cartilage that had been dragged away from

the lateral surface of the medial femoral condyle, close to the upper attachment of the posterior cruciate ligament. The body became free, and moved from place to place; it was readily removed, and the torn cruciate ligaments were sutured with catgut. When the specimen is examined, it is seen that in the short space of time from November, 1912, to February, 1913, the hyaline cartilage has almost completely covered in the bony surface of separation, which is roughened and somewhat irregular, contrasting markedly with the other smooth, free surface. Attached to the specimen may also be noticed a small cartilaginous polyp developing from the edge of the detached portion of the articular cartilage; this has, no doubt, grown from that portion of the synovial membrane which normally ensheaths the cruciate ligaments.

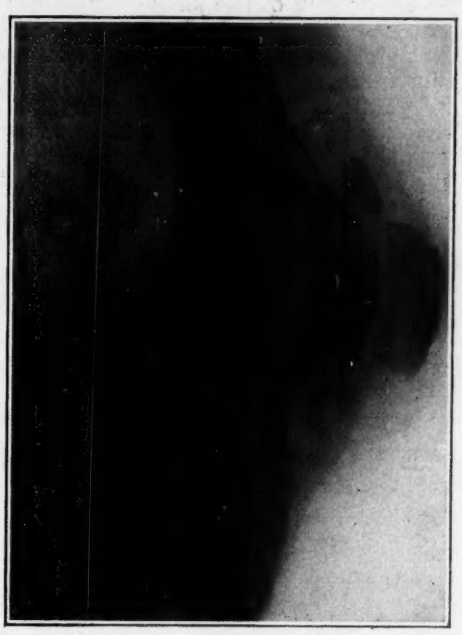


FIG. 455.—Solitary loose body, of 6 years' standing, in suprapatellar pouch. It was detached from the articular surface of the medial femoral condyle by a blow in falling down-stairs. It was known to be increasing in size.

FIG. 456.—Solitary loose body known to have moved about the joint for over 20 years. Consists of true bone covered by hyaline cartilage. *(Lent by Mr. C. W. Cathcart.)*

Fig. 455 shows a loose body in the suprapatellar pouch, detached by accident from the femoral condyle by a fall down-stairs some years previously.

Fig. 456 shows a cartilage which was known to have been free in a man's knee-joint for over twenty years. For the specimen I am indebted to Mr. C. W. Cathcart, of Edinburgh, who not only supplied me with it, but added to his kindness by writing the following account.

Jas. McK., aged 48. Complained of chronic synovitis of left knee, associated with the presence of a large, loose body, which lay in the synovial pouch above and to the outer side of the patella. The loose body had been first noticed twenty years before it was removed. The knee had been kicked by a pony, and had been much swollen and painful. Six months later, a loose body the size of a split pea was felt on the outer side of the joint, near the lower part of the patella. It would sometimes disappear, and then might get in between the articular surfaces and cause severe pain. It often appeared on

the inside of the ligamentum patellæ, and could then be pressed round the inside of the joint, to the top, and then across to the outer side. It could not be passed down the outside of the joint, but could be manipulated back the way it came, i.e., across the upper part of the joint to the inner side, and thence downwards along the inner border of the patella. In later years it had been kept above and to the outer side of the patella, as in other situations it was apt to find its way into the interior of the joint and cause pain.

It enlarged steadily, and at last seemed to be too big to wander about as before. The patient felt sure that it had had no pedicle or other form of attachment, almost from the time it was first observed.

It was removed under local anæsthesia, and was found quite free, as the patient had expected. Its nourishment must have come to it for many years through the synovial fluid alone.

It is alike interesting and important to note, in this reference, the tendency to the growth of hyaline cartilage over fractured and injured articular surfaces, as well as the fact which is so plainly established by the histories of these cases and the appearances of the specimens, that detached portions of articular cartilaginous surfaces, even when they are completely separated from all connections and are free, readily increase in size and *grow*. The fact is the more interesting as it is a new conception of our ideas of the growth of living tissues, nourished as the specimens must have been by imbibition or absorption, through their cartilaginous surfaces, of material from the synovial secretions. In Mr. Cathcart's case (*Fig.* 456), it is clear that the growth was continuous and steady, though slow, and not only did the body increase in size and weight, but it developed into a more highly specialized and organized tissue, viz., true spongy bone. The growth of such a loose cartilage may be likened to that of the cell of a metastatic growth, which continues to grow in its new locality while adhering to the characters of its parent growth, though independent of it, and which is possibly incapable of reproducing itself. So far as the writer is aware, no more definite evidence has hitherto been adduced to support this view or explain this method of growth in the animal body. It is a new fact added to biological knowledge, one which may prove of far-reaching interest in the light of recent experimental researches as they concern the growth of cells and simple tissues in artificial media. Now that the successful grafting of most human tissues and some organs is beyond dispute, and has been proved to be of incalculable service both to the science and practice of modern surgery, the life-history and growth of one of these freely-wandering, and completely detached, bodies must be of additional interest, and may some day prove to be of considerable practical importance.

4. *Loose bodies resulting from partial detachment of a semilunar fibro-cartilage.*

We have referred already to the effect of the chronic irritation set up by a movable portion of semilunar cartilage in a knee-joint, as producing papillary synovitis, hypertrophied fringes, and even cartilaginous and bony pedunculated bodies in an indirect manner.

That detached portions of semilunar cartilages, though rare, do sometimes give rise to loose bodies, few will deny. Sometimes a portion of cartilage is detached at the time of injury (*Fig.* 449); usually, however, it results from a later accident, as when the injured part has assumed a polypoid and pedunculated shape, so that it is caught between the articular surfaces of the bones and torn off during some awkward or unusual movement (*Fig.* 457).

The clinical features in these two latter groups are very similar, and the results the same; chronic synovitis, sudden and repeated wrenches and attacks of pain when the joint is used, followed by swelling and acute synovitis with lameness, and later even crippling. In those over thirty years of age there is in many cases a tendency to osteo-arthritis if the condition is neglected and the symptoms are allowed to drag on indefinitely without proper treatment. In a few cases the process has commenced before the age of thirty.

The differential diagnosis may be easy, or so difficult as to require an *x*-ray photograph or an exploratory operation for its establishment. Removal of the offending body by an open operation is the only reliable and satisfactory treatment.

5. *Loose bodies resulting from the entrance of foreign bodies into the joint.*—As the result of accident, foreign bodies have been known to enter the joint and lead to another variety of loose body. Sometimes they are inserted purposely.

FIG. 457.—Portion of anterior end of a medial meniscus (internal semilunar cartilage), which had been torn and become pedunculated and twisted upon itself.

Such a case is that of a hysterical girl, who inserted many needles at different times, when she needed an excuse for not returning to school or taking proper walking exercise. She had managed to insert as many as eighty such needles. They were free in the joint, and though rusty when removed, were not incrusted with fibrin.

Fig. 451 illustrates the pointed end of a steel compass which had been broken off, and had remained for fourteen years, in a youth's knee, and had given rise to *no* definite symptoms after the first attack of acute synovitis had subsided, until he recently had a fall which twisted the joint.

Directly after the recent sprain the joint became full of effusion, and from time to time the boy could feel a pricking sensation whenever the joint was bent and when he knelt, and there was pain on pressure at a point external to the patella. The skiagram shows the position in which the foreign body was found after an arthrotomy was performed for its removal. As stated before, the symptoms in each of these cases were comparatively slight. When the joint was opened, there escaped one and a half ounces of turbid fluid, blood-stained and containing brown, flattened, scale-like pieces of tissue resembling articular cartilage. These seemed to result from scratching of the femoral articular cartilage by the foreign body, against which it played in the movements of the joint.

On one occasion the writer extracted a sharpened piece of flint-stone, which had entered the knee through a wound near the lateral edge of the patella as the result of a bicycle spill, and which had remained in the joint for nine months. From time to time the boy suffered pain and had to lie up for acute attacks of synovitis, but he had no knowledge of the entrance of the foreign body until it was discovered by radiography and removed by arthrotomy. The interior of the joint showed a marked saffron-coloured pigmentation, but there was no roughening of the synovial surface except in the immediate neighbourhood of the stone.

There is still *another variety of loose body*—the true nature of which is as yet imperfectly understood—which has been met with by the writer on three occasions during recent operations for removal of torn semilunar cartilages (*menisci mediales et laterales*). The bodies are small, flattened, milky-white in colour, and have the appearance of superficial scales of cartilage. They float about in the synovial secretion and may be of considerable number; they consist of organized tissue and appear in healthy joints, thus differing from fibrin bodies (corpora oryzoidea) which are found in diseased conditions, and are homogeneous and composed mainly of fibrin.

It is possible that they are produced by bruising, or by a scale being set free when the torn semilunar cartilage is caught between the articular surfaces. They are peculiar also in that they vary much in size and are multiple. Personal experience is too limited to allow of any dogmatic statement as to their etiology or true nature; it is nevertheless certain that they exist, and it is thought advisable to describe them with a view to focussing the attention of others on them.

[The Basle anatomical nomenclature has been used throughout this article.]

TWO CASES OF COMPLETE DIVISION OF THE DUODENUM AT THE DUODENO-JEJUNAL JUNCTION TREATED BY CLOSURE OF THE DIVIDED ENDS AND GASTRO-JEJUNOSTOMY.

By H. COLLINSON and L. R. BRAITHWAITE, Leeds.

That the regular presence of bile in the stomach in itself produces no ill-effects and is compatible with comfort and good health, has been established experimentally on animals by several observers, and the operation of cholecyst-gastrostomy for irremovable obstruction of the common bile-duct is now a recognized method of treatment.

That the secretion of the pancreas also is equally well tolerated, was shown by the experiments of Steudel, and by the following case published by Moynihan.[1] We quote his account of the case in full.

E. H. L., a boy, aged 6, was admitted to the Leeds Infirmary on September 6, under the care of Mr. W. H. Brown, for whom I acted. The patient had sustained an abdominal injury which caused collapse and gave rise to the signs of increasing fluid in the peritoneal cavity. Without entering into details, it may be said that the case clearly demanded surgical intervention.

The following operation was performed:—

An incision 5 inches in length was made to the right of the middle line, extending from 1 inch below the ensiform cartilage downwards. On opening the abdomen there was an escape of blood, and blood was seen lying everywhere about the intestinal coils. A rapid search soon revealed the fact that there was a complete rupture of the intestine at the duodeno-jejunal flexure. The jejunum appeared to have been torn out from the duodenum in such a manner that the divided end of the duodenum was beneath the peritoneal level, and was ragged and irregular. The jejunum in its upper 4½ inches was torn away from the mesentery; this portion was removed. An end-to-end approximation was clearly impossible, as the cut duodenum was inaccessible. The duodenum was therefore closed as securely as possible with a continuous catgut stitch, and the peritoneum around it sutured over this stitch. In order to ensure a complete closure, the upper part of the mesentery, which had been torn away from the jejunum, was stitched as a sort of lid over the obliterated part of the duodenum. The jejunum was implanted in the anterior wall of the stomach with the aid of a Murphy button. After doing this, it was my intention to make an anastomosis between the lower portion of the duodenal loop and the jejunum, so as efficiently to drain the former, but the child seemed on the verge of death, and I had to complete the operation as speedily as possible. Stimulants, in the form of saline infusion, strychnine, and a hot-water enema were given during the operation, and one minim of strychnine was given every hour for the first twelve hours. The patient gradually rallied and made a good recovery.

After-History.—After the first ten days we had a skiagram made, and three were subsequently taken. On each occasion the button showed in a different position, and we were inclined to accept this as an indication that it was passing along the intestinal canal. The patient gained weight, ate ordinary diet, and was quite well, and his condition was in every way satisfactory. One untoward incident alone was observed, and this was a copious attack of vomiting, which we ascribed to a pork-pie injudiciously given by a friend on the visiting-day. The question of a second operation, the performance of an anastomosis between the duodenal loop and the

jejunum, was frequently discussed; but the condition of the child was so satisfactory that we were unwilling to interfere. The stools were examined, and pronounced normal in appearance and constitution.

Perforation.—On the 104th day after the operation the patient was suddenly seized with acute and overwhelming abdominal pain, and I was urgently summoned. I found him pale, pulseless, and utterly collapsed. He died an hour subsequently.

Post-mortem Examination.—A perforation of the duodenum at the lowest point of the loop was found, the perforation being due to the Murphy button, which lay in the ulcer its pressure had produced.

It was the knowledge of this case which encouraged the writers to adopt a similar procedure in the two which are now to be described.

Mr. Collinson's Case.

D. C., female, aged 17. The girl, who was a patient of Dr. Dodd, of Chapeltown, was admitted to the Leeds Infirmary under the care of Dr. Hellier on September 18, 1911, and subsequently transferred to Mr. Collinson.

On the previous day she had been seized with sudden abdominal pain, and had vomited several times; a tender tumour was felt in the left iliac and lumbar regions.

On admission, she was still suffering considerable abdominal pain, and vomited once or twice. Abdominal examination revealed a tumour the size of a small cocoanut occupying the left iliac and lumbar regions; it was fixed and tender, and evidently retroperitoneal, although its boundaries were ill-defined, owing to the rigidity of the abdominal muscles; it did not bulge the renal fossa behind, but was thought to be possibly a distended and misplaced kidney.

During the next day or two pain diminished, the muscular rigidity became less, and the tumour was found to occupy the left side of the abdomen, as low as the pelvic brim. Cystoscopy revealed no abnormality of the ureteral orifices, and the left kidney appeared to be functioning normally.

Operation was performed on September 25, the left loin being explored through a lumbar incision. The convex border and lower pole of the kidney were normal, and the tumour was found to be lying to the median side and in contact with its pelvis. The lumbar incision was partially closed, and the abdomen opened through a left rectus incision.

The tumour was then found to occupy the retroperitoneal tissue to the left of the attachment of the mesentery of the small intestine; it extended downwards to the pelvic brim over the bifurcation of the aorta, upwards to the lower border of the pancreas, and inwards towards the third part of the duodenum; the descending colon lay to its outer side. Some omental adhesions were separated from its surface, and as no large colic vessels were visible over its most prominent part, the overlying peritoneum was incised transversely, without attempting to displace the colon inwards.

The tumour was now carefully separated with the fingers from its surroundings, beginning at the lower pole, which lay over the bifurcation of the aorta and left iliac vessels; the ureter was seen and avoided, and the outer margin of the growth separated from the renal pelvis with which it was in contact; the greatest difficulty was experienced when an attempt was made to enucleate its upper portion; this passed upwards beneath the duodeno-jejunal flexure and the

third part of the duodenum, which were very tightly stretched over it. In separating the duodenum, a rent of about 2 inches in length was made in its retroperitoneal aspect; this was protected by gauze swabs, whilst the remaining connections of the tumour with the lower border of the pancreas were freed; at this stage the lesser peritoneal sac was opened.

After the removal of the growth, attention was directed to the torn duodenum; the laceration on its posterior aspect was found to be so extensive that an efficient closure could not be made owing to the lack of peritoneal covering, and it was decided to resect the torn portion of gut with the duodeno-jejunal flexure.

The duodenum was therefore clamped just to the left of the point of crossing of the superior mesenteric vessels, and divided; the proximal end was closed by a suture taking all the coats, and two more layers of suture brought the parietal peritoneum over the stump.

The jejunum was clamped and divided at a point about two inches below the flexure, and the intervening portion removed; the divided end was closed, and infolded by two layers of suture.

The posterior wall of the stomach was now brought out through the opening which had been made in the transverse mesocolon, and the jejunum anastomosed with it to form a posterior vertical gastro-enterostomy. The margins of the gap in the mesocolon were closed around the anastomosis, and, so far as was possible, the bed of the tumour was shut off from the general peritoneal cavity by approximating the edges of the parietal peritoneum. A drainage-tube was passed into the retroperitoneal space through the lumbar incision, and the anterior wound completely closed. The patient was returned to bed in fair condition and continuous proctolysis was ordered.

The tumour removed was the size of a cocoanut, and apparently arose independently of any organ. The pathologist's report is as follows:—

"This is a mesoblastic tumour, and may be described as a fibroma of embryonic type. The preponderating cell resembles the fibroblasts of young granulation tissue. There is nothing typical of sarcoma, and on the whole the tumour is probably simple. Throughout the growth there are areas of round and plasma cells, and in parts considerable new formation of blood-vessels with extremely thin walls. There are numerous foci of free hæmorrhage."

The patient rapidly recovered from the shock of the operation, and her convalescence was entirely uneventful.

All fluids by the mouth were withheld for thirty-six hours, but at the end of that time were given freely. Light solid food was given at the end of ten days. At no time after the operation was there any inclination to vomit.

The patient was seen in July, 1912, and an *x*-ray examination made after a bismuth meal. It was found that the stomach rapidly emptied itself through the gastro-enterostomy opening, and no bismuth was seen to pass into the closed duodenum.

She has remained quite well up to the present time.

Mr. Braithwaite's Case.

Mrs. N., age 60 years. Seen in consultation with Dr. Applegate, of Dewsbury, in August, 1912.

At that time there was a history of increasing constipation, with attacks of abdominal pain, existing over a period of eight months; relieved by enemata. It was thought that she had a growth in the large intestine, and she was advised that an operation might at any time become necessary.

On October 11, 1912, she was admitted into the Dewsbury Infirmary, and an operation was performed for acute intestinal obstruction. A small, easily-movable growth was made out at, or near, the splenic flexure; there were no secondary deposits in the liver or on the pelvic floor.

There was very marked distention of both small and large intestine above the growth. A Paul's tube was tied into the cæcum. During a period of five weeks she gradually improved. On November 27, 1912, an operation was undertaken for the removal of the growth.

A vertical incision was made through the left linea semilunaris, from the costal margin downwards. The growth was easily found and was the size of a tangerine orange; it occupied a position just above the splenic flexure, in the extreme left of the transverse colon. The omentum was adherent to it, and on trying to lift it out of the abdomen, the growth was found to be tightly bound down to the deeper structures.

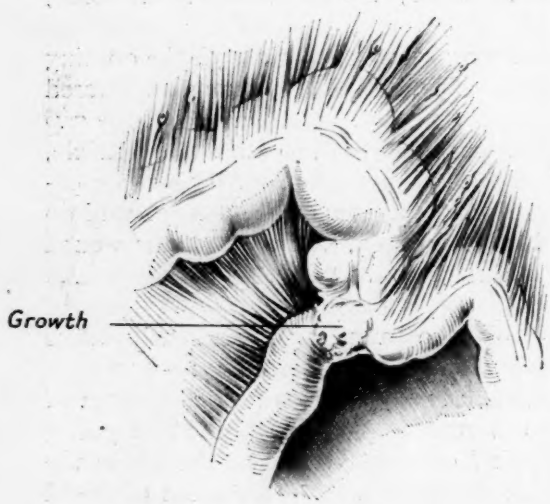


FIG. 458.—Showing growth at extreme left of transverse colon, and invading the jejunum below at the duodeno-jejunal junction.

Careful investigation revealed the fact that by reason of a downward and backward rotation of the colon, the growth had extended to, and was involving, the highest part of the jejunum at the duodenal flexure, and was invading the upper half of its circumference at this point (*Fig.* 458). There was no deep infiltration extending into the last portion of the duodenum, and no apparent involvement of the glands in the mesentery of the small bowel. A few glands were involved in the mesentery of the colon.

After some consideration, it was decided to resect the duodenal flexure with the portion of the large bowel containing the growth, and its lymphatic area. The splenic flexure and the descending colon were mobilized (Moynihan) by incision of the parietal peritoneum on their outer aspect, and stripped towards the middle line, with the mesentery and the contained glands, as far as the inferior mesenteric vein. The hugely hypertrophied transverse colon was divided between clamps four inches above the growth, and the atrophied descending colon was cut across, in a similar manner, about four inches below the growth. Both ends were wrapped in gauze and drawn apart. The mesentery was divided, with a portion of the omentum, and the vessels were ligatured as far down as the region of the duodenal flexure, taking away a V-shaped piece of the mesentery.

The inferior mesenteric vein was seen and avoided. The duodeno-jejunal flexure was now divided flush with the posterior abdominal wall, care being taken not to injure the superior mesenteric vessels.

Some leakage occurred from the duodenum, and was controlled by pressure on its second and third parts by means of a large flat swab. The lesser sac was now found to be opened, and was packed off by gauze, wrung out of hot saline.

The jejunum was divided at a point two inches below the growth, between an upper clamp and a lower modified Parker's crushing clamp (Moynihan); the lower end being closed and completely turned in (*Figs.* 459 and 460).

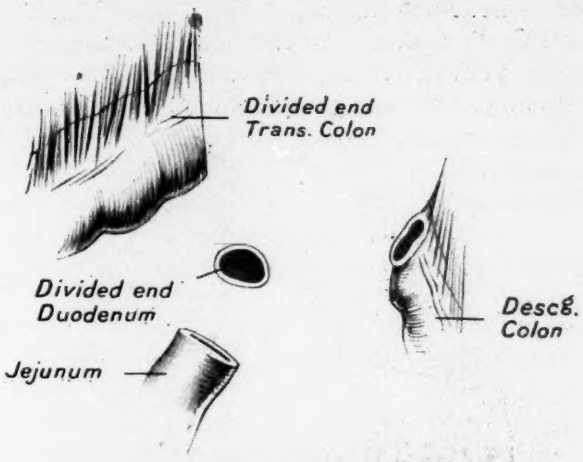


FIG. 459.—Showing where the different parts of the gut were divided.

It was impossible to perform either an end-to-end or a lateral approximation of the duodenum to the jejunum, because there is not complete investment of the duodenum by peritoneum at this point, and because there was not sufficient material in the duodenum available for stitching purposes. The divided end of the duodenum was therefore closed by three rows of Pagenstecker sutures, drawing over the stump a double layer of parietal peritoneum.

FIG. 460.—The same as the previous figure, showing the closure of the divided ends of the duodenum and jejunum.

Posterior gastro-jejunostomy was quickly performed, the upper part of the jejunum, well below the closed divided end, being utilized. It was found that the mesentery of the jejunum lay naturally over the closed end of the duodenum and, as an additional precaution to avoid leakage from the duodenum, this additional layer of peritoneum was fixed over it by ligatures. The divided ends of the colon were now approximated and united end-to-end in the usual way, except that, owing to the enormous hypertrophy of the higher part, a portion of its lumen had to be closed at both upper and lower margins to make it approximate to the lower and smaller divided end of the descending colon. Omental flaps were fixed to this line of suture at its circumference (*Fig.* 461).

The gap in the mesentery was closed and the lesser sac shut off. A stab-puncture was made in the left kidney-pouch, and a large drainage-tube passed through into the loin. The anterior wound was closed in layers.

Dr. Applegate most ably assisted in a long and difficult operation, and Dr. McCool's administration of the anæsthetic gave us neither trouble nor anxiety. The patient left the table in a good condition, the pulse rate being only 86 per minute. She was given rectal infusion of saline and placed in Fowler's position.

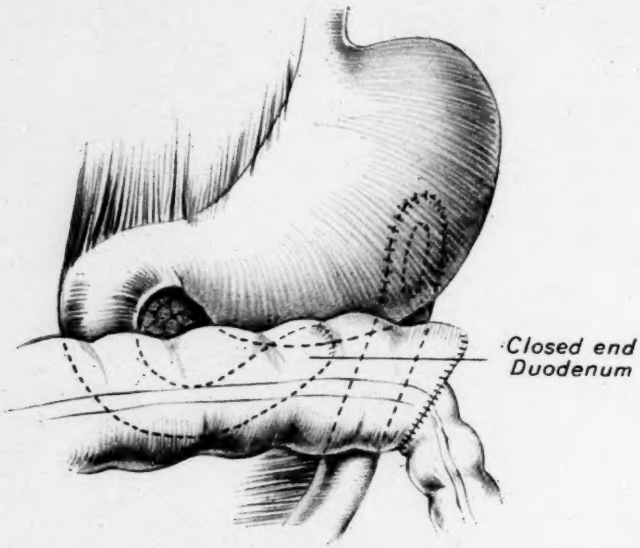


FIG. 461.—Showing the transverse and descending colon united, and the anastomosis of the ileum with the posterior wall of the stomach.

During the next few days she vomited frequently, and her condition gave cause for some anxiety.

Nov. 30.—She was retching and vomiting persistently, and her pulse rose to 130 per minute.

Dec. 1.—Much better, the pulse falling to 118: the vomiting ceased.

Dec. 3.—Lumbar drain removed. No discharge. Some intestinal distention.

Dec. 4–6.—Some discharge from the anterior wound, becoming markedly fæculent. Much abdominal distention.

Dec. 7.—The typhlotomy opening, which had almost closed, was dilated, and the distention at once relieved.

Dec. 9.—Some fæcal result from an enema.

Dec. 10.—Bowels opened twice naturally.

Dec. 14.—Formed motions passed. The discharge from the anterior wound ceased, and the typhlotomy wound closed naturally.

Except for occasionally vomiting a little bile, she made constant improvement. She was up on Jan. 3, and home on Jan. 11, 1913. From May 1–18, 1913, she was in the General Infirmary at Leeds for the purpose of observation. The bowels were acting normally, and there was no sign of recurrence of the growth. An *x*-ray examination was made by Dr. Rowden, who reported, "The gastro-enterostomy opening is quite patent; the stomach is almost empty in 4½ hours; no food is seen in the duodenum."

In this case there was much discomfort by reason of frequent attacks of gaseous eructation with vomiting, the vomit having a curiously sour odour.

She left the district in June, and was reported in Jan. 1914, as "doing well."

Food has to be carefully selected, and nothing in the nature of a heavy mass, unmixed with fluid, is ever taken. Most things can be digested with comparative

comfort, except during an attack of eructation and vomiting, when milk and soda alone is accepted.

In one of these cases, as in Moynihan's original case, the presence of bile and pancreatic juice causes no discomfort, and digestion appears to be quite satisfactory, provided reasonable care is taken. In the case of Mrs. N., occasional attacks of severe discomfort alternate with periods of perfect health.

We have quoted the cases in detail, because we feel that, whilst the occasions on which the operation may need to be performed are not very frequent, a knowledge of its practicability may occasionally open up a line of procedure to the surgeon which will help him out of a difficult situation.

The injury in Moynihan's case is not a very uncommon one, and secure union of the torn intestine is practically impossible; closure of the proximal end and gastro-jejunostomy provide a safe and satisfactory way out of the difficulty.

It has occurred to us that in cases of jejunal or gastro-jejunal ulcer, a similar operation may be of value. Both varieties of ulcer occasionally occur, even in the modern " no-loop " posterior gastro-enterostomy, and the operative treatment of the condition presents one of the most difficult problems in surgery. The excision of a large ulcer at the anastomotic opening, or in the jejunum a short distance below it, may make a satisfactory restoration of the junction a matter of great difficulty. The etiology of these ulcers is by no means clear, but, as Paterson[2] has pointed out, there is evidence to show that they are the result of an abnormal gastric secretion acting upon the raw surface of the suture line or on the jejunal mucosa; in some cases this abnormality may be due to inefficient drainage of the stomach, as in the anterior operation; in others to the presence of some focus of septic absorption, e.g., in the appendix, as Moynihan[3] has suggested; but neither of these explanations holds good in every case. Whatever the cause of the abnormality in the secretion, it seems probable that the hydrochloric acid is an important agent in the ulcerative process.

The excision of the ulcer alone is apt to leave unaltered the conditions which determined its original formation, and even when this is combined with the provision of a larger and better anastomosis, a recurrence of ulceration is liable to occur.

Moynihan[3] quotes three cases of jejunal ulcer operated upon by him, in one of which a second operation was necessary, and he points out the great difficulties which may arise in operative treatment.

Paterson[4] suggests that in cases of recurrence, the proximal limb should be implanted into the stomach and a separate anastomosis performed between the distal limb and the stomach, and this is a suggestion which is very useful; but we can conceive of a case in which a large gastro-jejunal ulcer, combined with a very short " loop," would make even this proceeding most difficult.

The diversion of the bile and pancreatic juice into the stomach by this method, or the one we suggest, would remove the acid factor in the production of ulceration, and to this extent would be of benefit. The complete closure of the duodenum cannot, of course, be considered unless the pylorus is reasonably patent; but jejunal ulcer appears to be relatively infrequent after gastro-enterostomy for severe pyloric stenosis, in which acidity tends to be reduced, and it is questionable whether the modern method of infolding of a duodenal ulcer or the pylorus

as an adjunct to gastro-enterostomy produces such a grade of permanent stenosis as would prevent the bile and pancreatic juice finding their way back into the stomach without difficulty. In a difficult case it might be possible to combine a pyloroplasty or Finney's operation with the one suggested.

The occurrence of perforation in the duodenal loop in Moynihan's case, and the fact that in Steudel's experiments on dogs, perforation similarly occurred as the result of ulceration due to fragments of bone, make one hesitate to recommend the operation except in very occasional cases. In the two which we quote, *x*-ray examination shows that no part of the contents of the stomach passes through the pylorus, but that the viscus rapidly empties itself through the anastomotic opening.

The patients should, however, take great care in diet, and avoid all foods containing seeds or any hard and unabsorbable portion, and mastication should be very thorough.

REFERENCES.

[1] MOYNIHAN, *Brit. Med. Jour.*, 1901, i, 1136.
[2] PATERSON, Surgery of the Stomach, 100.
[3] MOYNIHAN, Duodenal Ulcer. 2nd ed.
[4] PATERSON, *loc. cit.*

A CASE OF INTUSSUSCEPTION OF THE VERMIFORM APPENDIX.

By R. J. M'CONNELL and W. WILSON, Belfast.

Intussusception of the vermiform appendix, being a rare condition almost entirely confined to children, the following case, occurring as it did in an adult of 50 years, seems worthy of publication.*

Kelly and Hourdon, in their work on the appendix, have collected and recorded 19 cases in children of an average age of 4 years 8 months, and only one case in an adult, a woman aged 40.

We are indebted to Mr. Sinclair for permission to publish notes on this case, which was under his care in the Royal Victoria Hospital, Belfast.

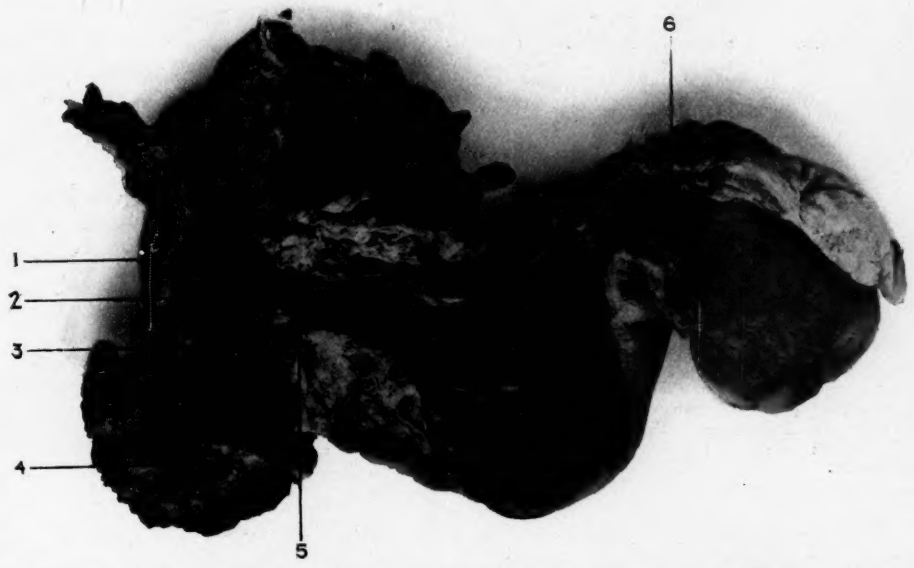


Fig. 462.—Photograph of resected portion of Intestine, opened along its Anterior Surface. (*W. Wilson.*)

(1) Third stricture; (2) Anterior wall of cæcum; (3) Intussuscepted appendix; (4) Mass of inflammatory tissue; (5) Second stricture; (6) First stricture.

L. McM., a housewife, aged 50 years, was admitted to the hospital on February 15, 1913. For three years previously she had been troubled with vague abdominal uneasiness which, in the last two months, developed into a well-defined deep-seated pain in the right ilio-lumbar region. This pain was of a throbbing and stabbing character, and radiated down the front of the right thigh. She had failed greatly since the new year.

* For literature see "Appendicitis," 3rd edition, by J. B. Deaver.

On admission to the hospital the patient was emaciated, and a hard immovable tumour was easily palpable through the thin abdominal wall. This tumour occupied the right iliac fossa, was about the size of a potato, and of uneven surface.

Whilst under observation she ran a normal temperature. Her stools contained a considerable quantity of mucus, but were otherwise normal. On opening the abdomen, Mr. Sinclair found the cæcum indurated, firmly bound down to the right iliac fossa, and surrounded by matted omentum. The serous surface of a stricture of the ileum, nine inches above the ileo-cæcal valve, was studded with what appeared to be typical tubercles. A lateral anastomosis was carried out between the ileum proximal to this stricture and the ascending colon; the terminal foot of ileum, the cæcum, and first 3 inches of ascending colon were then removed.

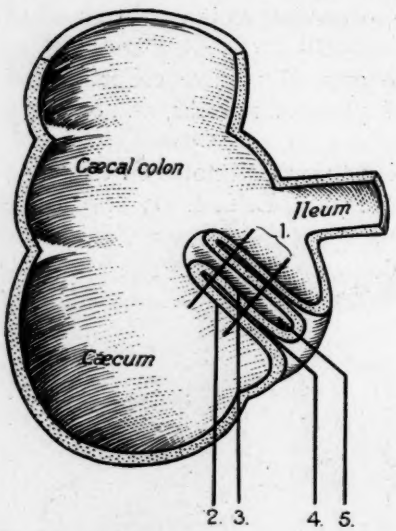


FIG. 463.—DIAGRAM TO SHOW CONDITION OF APPENDIX.

(1) Portion of appendix from which the sections illustrating text were taken; (2) Outer mucous membrane; (3) Inner mucous membrane; (4) Fused serous coats; (5) Lumen of intussuscepted appendix.

On superficial dissection of the resected portion, no trace of the appendix was found. The gut was then laid open along the anterior surface of the ileum, the cæcum, and the cæcal colon.

Three strictures were present (*Fig.* 462): one in the ileum, 9 inches above the ileo-cæcal valve, admitting a pencil; one at the junction of the ileum and the cæcum; and a third between the cæcum and the cæcal colon, the two latter admitting only a fine probe.

A polypoid protuberance was found lying in the cavity of, and attached by its base to, the floor of the cæcum, its free end extending almost to the third stricture. An orifice situated on the apex of the protuberance led into a canal which admitted a bristle for a distance of half an inch.

The structure was thought to be an intussuscepted appendix, and this was confirmed by subsequent microscopic examination.

The diagram (*Fig.* 463) shows the actual condition present, and the levels at which the various sections illustrating the text were made.

Portions of the protuberance were excised and prepared for microscopic examination in the ordinary way.

A transverse section of the protuberance (*Fig.* 464) shows a tubular structure, lined internally and externally by mucous membrane.

The following layers are seen from the lumen to the periphery:—

1. *Inner mucous membrane* (*Fig.* 465).—Practically normal, showing typical columnar epithelium and Lieberkuhn's crypts. A few small areas of hyperæmia were seen in some of the sections.

2. *Muscularis mucosa* (*Fig.* 465).—Normal and well-developed.

3. *Submucosa.*—Very vascular; the walls of the blood-vessels are thickened.

The lymph follicles, some of which are hyperæmic, are almost entirely confined to this layer. About the normal number of fat-cells are present.

4. *Muscular and fibrous layer* (*Fig.* 464).—Owing to the large amount of fibrous tissue in this region, the relations of the muscular coats are somewhat obscured, and in no single area of any of the sections examined could four muscular coats be distinctly demonstrated.

A well-marked layer of circular non-striped muscular fibres is seen in all the sections, and longitudinal fibres were easily identified by a combination of hæmatein and van Gieson's stain.

5. *Outer submucosa* (*Fig.* 466). — Presents much the same features as the inner, but in places is infiltrated with leucocytes. The lymph-follicles are more hyperæmic than those of the inner layer.

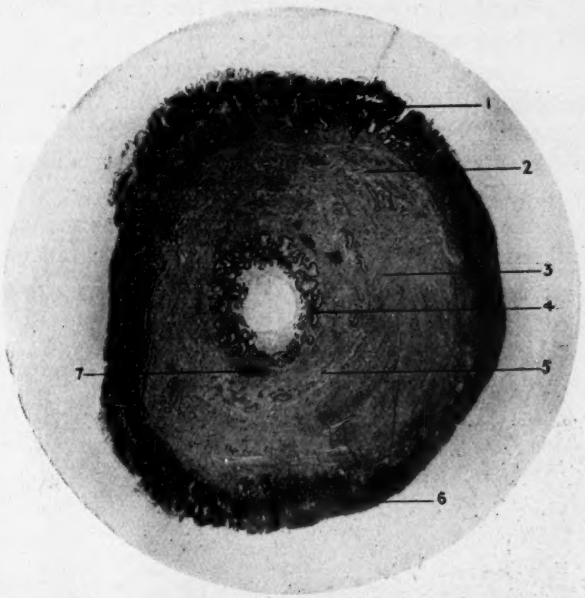


FIG. 464.—PHOTOMICROGRAPH OF A TRANSVERSE SECTION OF THE INTUSSUSCEPTED APPENDIX (× 6). (*R. J. McConnell.*)

(1) Outer mucous membrane; (2) Submucosa; (3) Muscular and fibrous layer; (4) Inner mucous membrane; (5) Inner submucosa; (6) Granulation tissue replacing outer mucous membrane; (7) Lymph follicle.

FIG. 465.—PHOTOMICROGRAPH OF INNER MUCOUS MEMBRANE (× 35). (*R. J. McConnell.*)

(1) Crypt of Lieberkuhn; (2) Lymph follicle; (3) Muscularis mucosa.

6. *Muscularis mucosa* (*Fig.* 466).—Similar to the inner layer.

7. *Mucous membrane* (*Figs.* 466 and 467).—This coat, in marked contrast to the mucosa lining the lumen, is intensely inflamed, and in different parts shows the various stages of inflammation and repair.

In some areas the capillaries are intact, but engorged and dilated with erythrocytes (*Fig.* 466); in others, the stroma is infiltrated with leucocytes and the epithelium desquamated. In *Fig.* 467 a transition stage is seen; on the left the mucosa is intensely inflamed, whilst on the right it is replaced by granulation tissue.

A section through the apex of the protuberance shows a tubular structure composed entirely of mucous

membrane, with crypts of Lieberkuhn opening both on the periphery and into the lumen.

Sections were stained by the Ziehl-Neelson method for tubercle bacilli; but none were found.

The extensive inflammatory changes seen in the mucosa covering the periphery of the protuberance compared with the normal condition of that of the lumen is very interesting from the etiological side. In Kelly's opinion, inversion of the appendix may commence with a swelling of the mucous membrane of its proximal end, and a pouting of this into the cæcum.

In the case under consideration, this explanation probably holds good. The inflammatory processes beginning in the mucosa of the base of the appendix

FIG. 466.—PHOTOMICROGRAPH OF OUTER MUCOUS MEMBRANE (× 35). (*R. J. McConnell.*)

(1) Inflamed mucous membrane; (2) Crypt of Lieberkuhn; (3) Muscularis mucosa; (4) Leucocyte infiltration; (5) Fat cell.

FIG. 467.—PHOTOMICROGRAPH OF OUTER MUCOUS MEMBRANE, SHOWING TRANSITION AREA (× 35). (*R. J. McConnell.*)

(1) Granulation tissue; (2) Inflamed mucous membrane; (3) Muscularis mucosa; (4) Artery; (5) Leucocyte infiltration.

would cause a localized swelling, projection of which into the cæcum would form the starting-point of the intussusceptum. This would then increase in size by a gradual spread of the inflammation, the swollen area always entering the cæcum, and the other coats of the appendix following it; the intussusceptum thus growing at the expense of the entering layer in the same manner as occurs in the ileo-colic variety of intussusception. The above explanation is in entire agreement with the fact that the mucosa of the lumen has remained practically normal, while that of the periphery shows inflammatory changes everywhere. It is quite obvious that, had the processes described above continued, a complete inversion of the appendix might have resulted; this was prevented, however, by the fusion of the peritoneal and muscular coats of the entering and returning layers of the intussusceptum.

THE ARTERIAL SUPPLY OF THE RECTUM AND PELVIC COLON.

By HAMILTON DRUMMOND, Newcastle-on-Tyne.

Of recent years much has been written concerning the arterial anastomosis of the recto-sigmoidal junction. The injections, as illustrated in this paper, have been carried out to show, in the first place, the recto-sigmoidal anastomosis, and in the second, the anastomosis between the superior and middle hæmorrhoidal arteries.

Technique.—In the specimens the injection, consisting of barium sulphate and almond oil, was pumped with a strong syringe into the inferior mesenteric artery, cut off at its origin from the aorta. It was found that if the left colic artery was not tied, the injection in most instances would travel up and fill the vessels given off by the superior mesenteric. When a ligature had been applied to the superior mesenteric artery at its origin from the aorta, it was possible to to inject, through the inferior mesenteric, the whole of the large and small intestine area up to the duodenum.

Rubesch[1] had already found that the injection of the whole could be brought about in the opposite direction by injecting through the superior mesenteric artery. This is an interesting anatomical fact, but clinically considered it seems unlikely that a collateral circulation could be provided quickly enough to prevent gangrene after ligation of the superior mesenteric artery.

The inferior mesenteric artery is given off from the abdominal aorta about 1½ to 2 inches from its lower end. According to Jamieson and Dobson,[2] it arises from that vessel under cover of the duodenum. In carrying out these injections, I frequently found in children, and occasionally in adults, where there was no ptosis of the duodenum, that the inferior mesenteric artery originated from the abdominal aorta half an inch, or sometimes one inch, below the lower border of the duodenum.

About an inch from its origin the trunk gives off the left colic artery, which divides into an ascending and a descending branch.

The point at which the artery divides into its two main branches is a variable one. The upper branch anastomoses with a branch from the middle colic, and the lower one anastomoses with the first of the sigmoid branches, sending a vessel upwards in addition, as a rule close to the bowel, to join its upper branch.

A large loop is therefore formed between the upper and lower branches of the left colic artery.

The sigmoid arteries from the inferior mesenteric supply the lowest part of the descending colon and the iliac and pelvic colons by a series of loops which anastomose above with the lower branch of the left colic, and below with the main trunk of the superior hæmorrhoidal artery.

These sigmoid arteries are given off in an erratic manner. Of 20 cases injected, the first of the sigmoid branches was given off from the left colic, or a

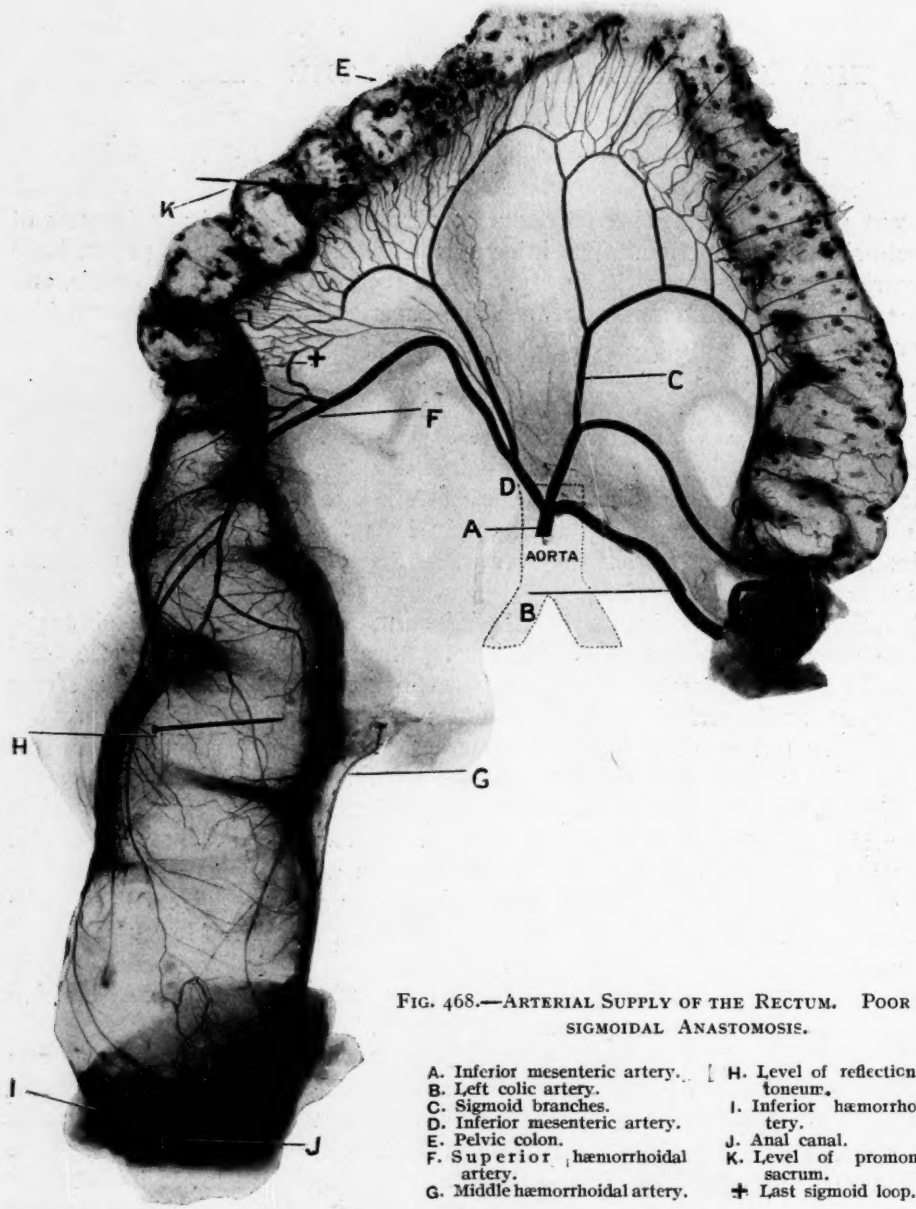


FIG. 468.—ARTERIAL SUPPLY OF THE RECTUM. POOR RECTO-SIGMOIDAL ANASTOMOSIS.

A. Inferior mesenteric artery.
B. Left colic artery.
C. Sigmoid branches.
D. Inferior mesenteric artery.
E. Pelvic colon.
F. Superior hæmorrhoidal artery.
G. Middle hæmorrhoidal artery.
H. Level of reflection of peritoneum.
I. Inferior hæmorrhoidal artery.
J. Anal canal.
K. Level of promontory of sacrum.
+ Last sigmoid loop.

The middle hæmorrhoidal artery is seen (G): in this case a small vessel which does not anastomose freely with the superior hæmorrhoidal artery. The branches of the latter artery freely supply the ampulla of the rectum. The spots in the pelvic colon are due to submucous ruptures of the injection under high pressure. The superior hæmorrhoidal artery divides midway between the level of the promontory of the sacrum (K), and the level of the reflection of the peritoneum (H).

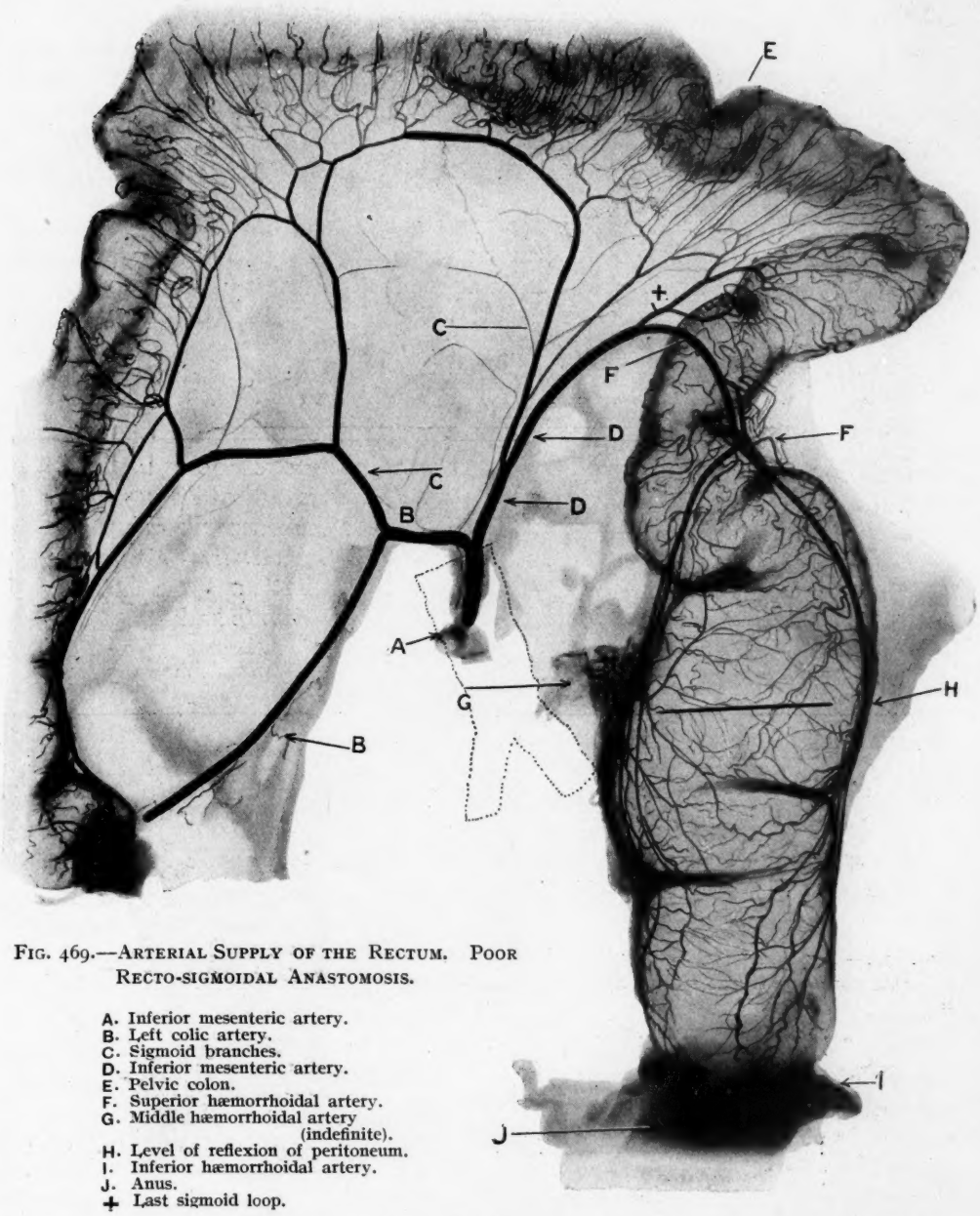


FIG. 469.—ARTERIAL SUPPLY OF THE RECTUM. POOR RECTO-SIGMOIDAL ANASTOMOSIS.

A. Inferior mesenteric artery.
B. Left colic artery.
C. Sigmoid branches.
D. Inferior mesenteric artery.
E. Pelvic colon.
F. Superior hæmorrhoidal artery.
G. Middle hæmorrhoidal artery (indefinite).
H. Level of reflexion of peritoneum.
I. Inferior hæmorrhoidal artery.
J. Anus.
+ Last sigmoid loop.

The division of the two branches of the left colic artery is well shown. The middle hæmorrhoidal artery is represented by a bunch of minute twigs showing no definite anastomosis with the superior hæmorrhoidal artery, which supplies the lowest part of the rectum with long branches. The inferior hæmorrhoidal artery is seen on the right of the picture.

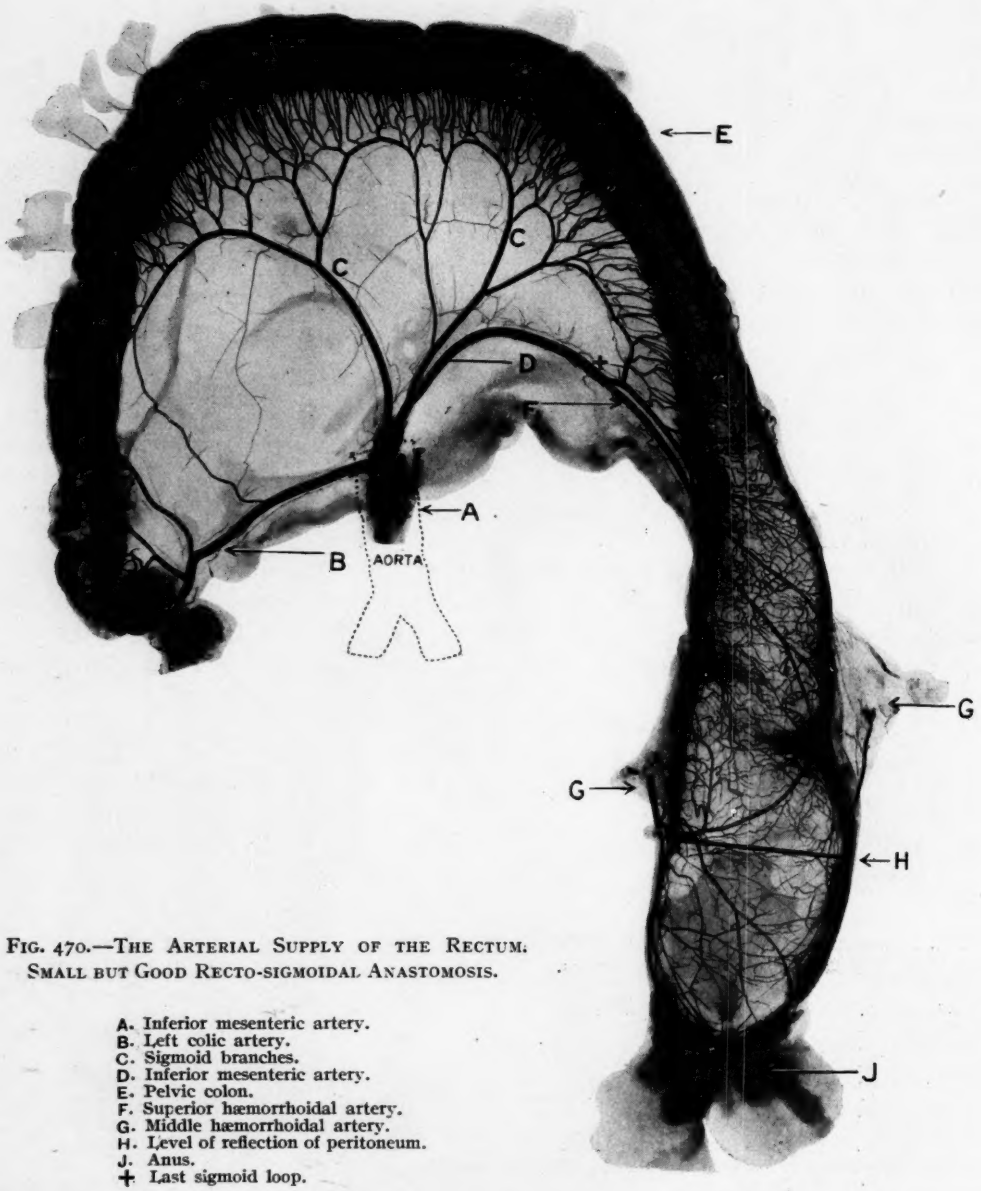


FIG. 470.—THE ARTERIAL SUPPLY OF THE RECTUM. SMALL BUT GOOD RECTO-SIGMOIDAL ANASTOMOSIS.

A. Inferior mesenteric artery.
B. Left colic artery.
C. Sigmoid branches.
D. Inferior mesenteric artery.
E. Pelvic colon.
F. Superior hæmorrhoidal artery.
G. Middle hæmorrhoidal artery.
H. Level of reflection of peritoneum.
J. Anus.
+ Last sigmoid loop.

High bifurcation of the superior hæmorrhoidal artery (F). Very well-marked anastomosis between the superior and middle hæmorrhoidal arteries (F) and (G).

branch of it, 11 times ; in the remainder of the cases, 9 in number, it sprang from the main trunk of the inferior mesenteric artery.

The remaining two or three branches arise from the main trunk of the inferior mesenteric artery, the arcades which they form anastomosing freely with each other. The lowest sigmoid branch does not form an anastomosis with the superior hæmorrhoidal artery in this arcade fashion.

The superior hæmorrhoidal artery forms no anastomosing arcade, but is, so to speak, a terminal artery.

The arterial anastomosis at this point, the recto-sigmoidal junction, is of interest on account of the important bearing it has on operations devised to remove the lower colon and rectum.

Hartman[3] found that, after operations by the sacral route upon carcinomata situated high up in the rectum, gangrene occasionally followed in the portion of the bowel which had been freed to permit of the establishment of a perineal or sacral anus.

De Dietrichs,[4] one of many who has made post-mortem investigations on this point, showed that by ligature of the inferior mesenteric artery above the origin of the last sigmoid branch, the circulation of the rectum was not affected ; but ligation of the artery (inferior mesenteric) below the last sigmoid branch, arrested the circulation to the rectum, and gangrene in the living subject would be inevitable.

Hartman[5] states that if the operator, after excision of the rectum, wishes to bring the bowel, with a satisfactory circulation maintained, down to the level of the skin of the perineum without traction, it is necessary to avoid cutting the superior hæmorrhoidal arteries where they are necessarily divided when working exclusively from the perineum. A ligature must be placed high up on the common trunk of these arteries, above the last anastomotic loop, which is to be found a little lower than the level of the promontory of the sacrum. To do this the abdomen must be opened. Hartman himself was the first to open the abdomen and tie the superior hæmorrhoidal artery to check hæmorrhage and to allow of an easier mobilization of the rectum. Sudeck,[6] however, was the first to point out the importance of an abdominal incision in order to find the exact position of this anastomosis, which he called the C.P. (critical point).

A careful study of the blood-vessels of this part of the bowel shows that the last sigmoid branch of the inferior mesenteric not only varies considerably in size, but that it has an erratic communication with the sigmoid branch above. (Anastomosis marked +.) Out of my 20 cases, the loop between the last sigmoid artery and the anastomosing branch above it was completely absent in 2. In 8 cases a loop was present, but was so insignificant that one would certainly think it could not be good enough to carry on the circulation after ligation of the inferior mesenteric artery. In the other 10, a well-marked loop of some size was present. In the majority of cases, one or two branches which run around the bowel on each side, and have a little anastomosis above or below, are given off from the superior hæmorrhoidal artery below the last sigmoid branch.

The superior hæmorrhoidal artery divides—as a rule, at the upper end of the rectum or a little lower—into two main branches which spread out on the lateral aspects and front of the bowel. These two main trunks soon give off numerous

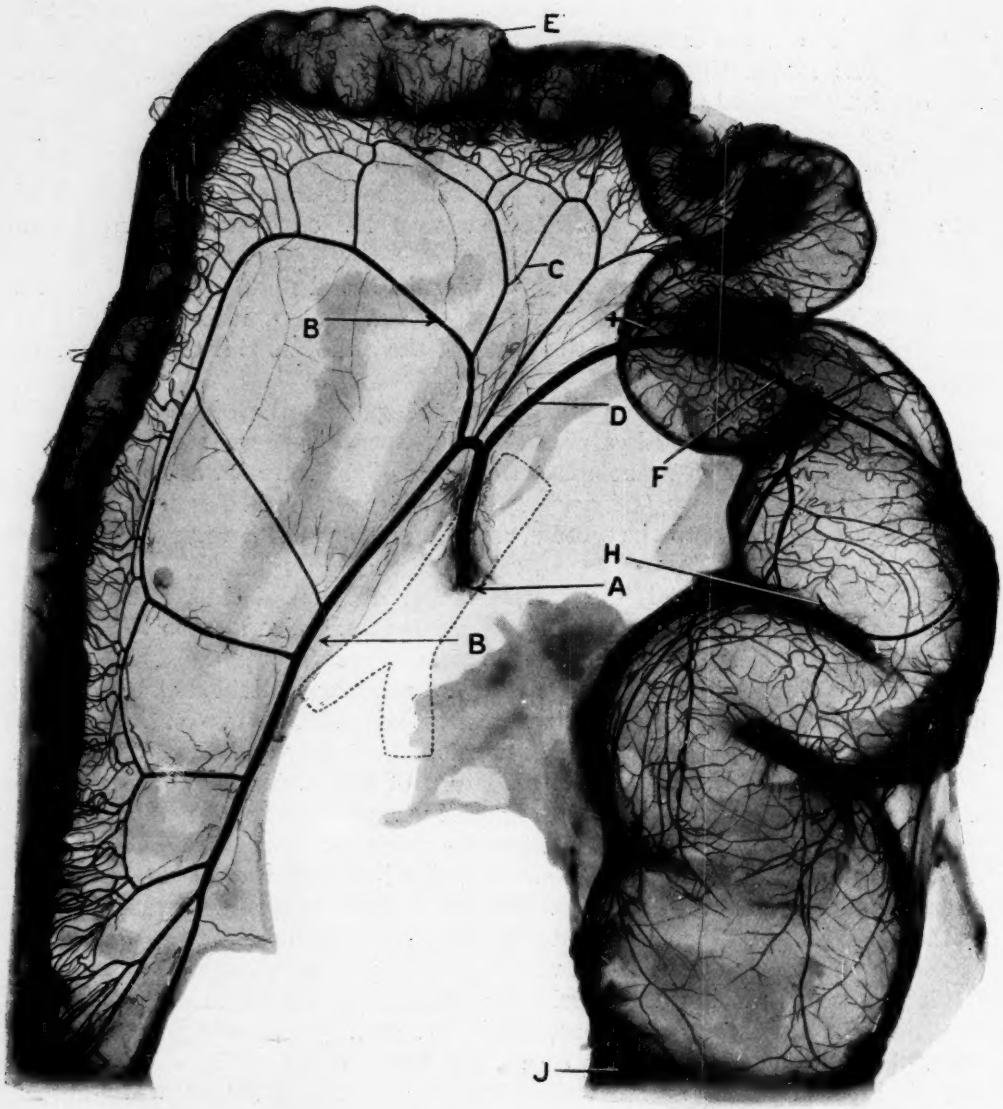


FIG. 471.—ARTERIAL SUPPLY OF THE RECTUM. GOOD RECTO-SIGMOIDAL ANASTOMOSIS.

A. Inferior mesenteric artery.
B. Left colic artery.
C. Sigmoid branches.
D. Inferior mesenteric artery.
E. Pelvic colon.
F. Superior hæmorrhoidal artery.
H. Level of reflection of peritoneum.
J. Anus.
+ Last sigmoid loop.

Sigmoid branches are seen arising from the left colic artery. The middle hæmorrhoidal artery is injected. The branches of the superior hæmorrhoidal artery are seen running down to the lowest part of the rectum.

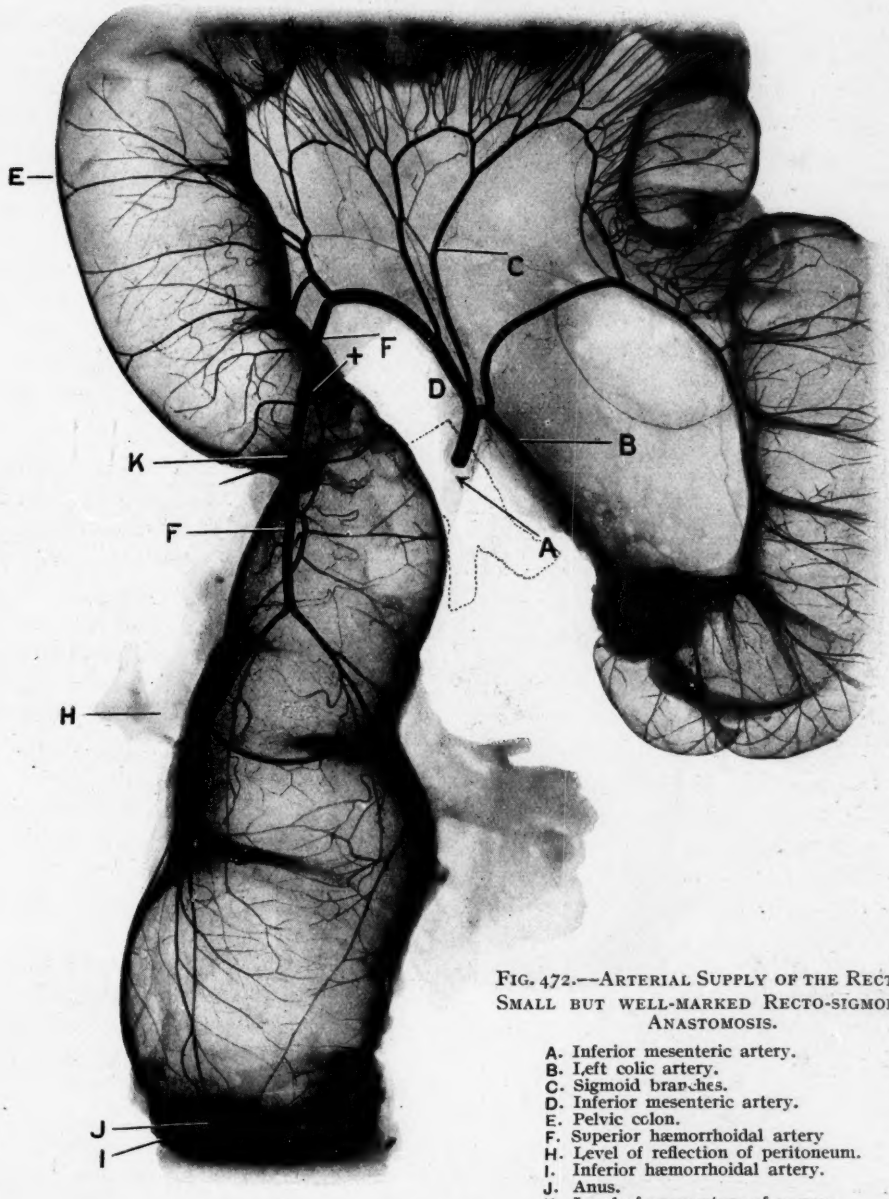


FIG. 472.—ARTERIAL SUPPLY OF THE RECTUM. SMALL BUT WELL-MARKED RECTO-SIGMOIDAL ANASTOMOSIS.

A. Inferior mesenteric artery.
B. Left colic artery.
C. Sigmoid branches.
D. Inferior mesenteric artery.
E. Pelvic colon.
F. Superior hæmorrhoidal artery
H. Level of reflection of peritoneum.
I. Inferior hæmorrhoidal artery.
J. Anus.
K. Level of promontory of sacrum.
+ Last sigmoid loop.

The left colic artery is seen dividing into two branches close to the origin of the artery. The middle hæmorrhoidal artery is absent; the ampulla and lower end of rectum are supplied by the branches of the superior hæmorrhoidal artery. Division of the superior hæmorrhoidal artery taking place about midway between the level of the promontory of the sacrum and reflexion of the peritoneum.

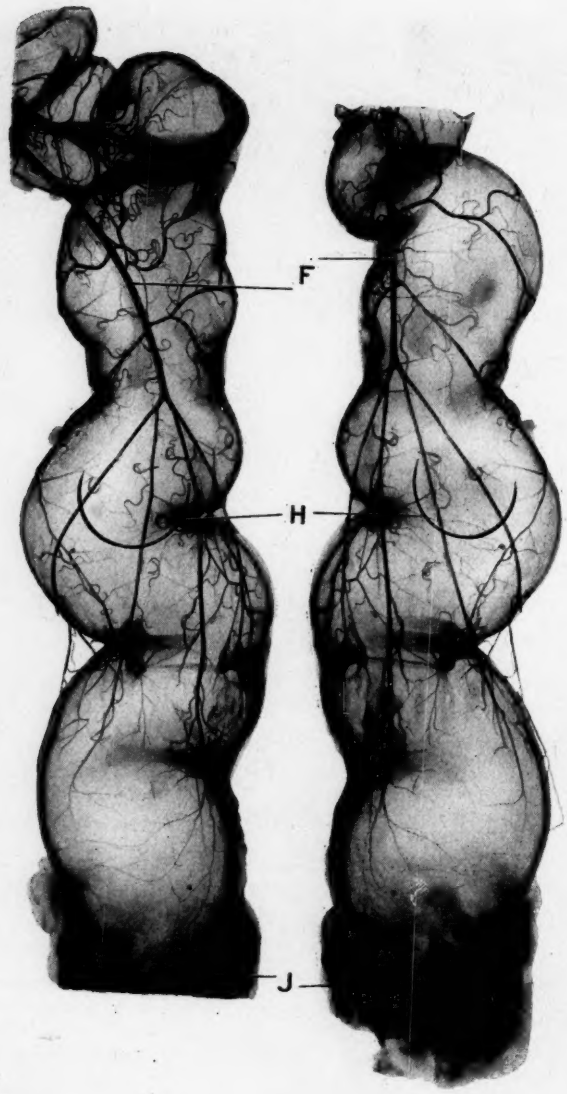


FIG. 473.--SPECIMEN OF THE LOWEST PORTION OF THE PELVIC COLON, RECTUM AND ANUS.

F. Superior hæmorrhoidal artery.
H. Level of reflection of peritoneum.
J. Anus.

The illustration well shows the way in which the branches of the superior hæmorrhoidal artery supplying the upper part of the rectum come off the main trunk at right angles, and anastomose very slightly with one another. The middle hæmorrhoidal artery is not shown. Illustrates well the breaking up of the main trunk of the superior hæmorrhoidal artery into its branches (in this case double).

small branches which form a free anastomosis around the ampulla of the rectum, and which can easily be traced down to the upper end of the anal canal. On reaching the middle of the ampulla, the branches perforate the muscular coat and come to lie in relation to the inner coat of the bowel.

The anastomosis between the superior and middle hæmorrhoidal arteries is shown to be a variable one, for these specimens were all injected by the same method and with the same material. In only three out of twelve could the middle hæmorrhoidal artery be clearly shown. In all the specimens the tissue containing this artery was dissected off from the bowel, so that injection could easily make it visible on the *x*-ray picture if it was of sufficient size. From these specimens we may conclude that in most cases the middle hæmorrhoidal has not, as the text-books lead one to suppose, a free anastomosis with the superior hæmorrhoidal artery.

In only two of the specimens could the inferior hæmorrhoidal artery be seen—suggesting that this artery, like the middle hæmorrhoidal, does not anastomose freely with the superior.

CONCLUSIONS.

1. The anastomotic loop formed by the last sigmoid artery (marked + in the photographs) varies considerably in size and position, and in some cases may be absent.

2. Gangrene in the stump of the bowel brought down after high excision of the rectum by the sacral route may be due to (*a*) anatomical causes, or (*b*) tension sufficient to arrest the already handicapped circulation. It seems probable that tension is the more important of the two.

3. To insure that the inferior mesenteric artery is tied in a suitable situation, i.e., above the last sigmoid branch, it is necessary to open the abdomen. If the recto-sigmoidal loop is small, any attempt to draw down the bowel to the perineum is likely to result in gangrene, and permanent colostomy should be done.

4. In the abdomino-perineal operation for excision of the rectum, it is safe to ligature the inferior mesenteric artery immediately below the point where the left colic artery is given off when a permanent colostomy is made.

5. If the bowel above is to be brought down to the anus after excision of the rectum by the abdomino-perineal method, the most convenient place to ligature the inferior mesenteric artery is immediately below the first sigmoid branch, which is to be recognized by the large anastomotic loop it usually forms with the branch of the left colic artery.

REFERENCES.

[1] RUBESCH, *Beit. Klin. Chir.*, 1910, lxviii, 480.
[2] *Proc. Roy. Soc. Med.*, 1909, March.
[3] *Ann. Surg.*, 1909, Dec.
[4] Quoted by HARTMAN, *Ann. Surg.*, 1909, Dec.
[5] *Loc. cit.*
[6] *Münch. med. Woch.*, 1907, 1314.

VISITS TO SURGICAL CLINICS AT HOME AND ABROAD.

NOTES OF PROFESSOR RUTHERFORD MORISON'S CLINIC AT NEWCASTLE-UPON-TYNE.

THE Royal Victoria Infirmary, situated in Leazes Park, a part of the town moor, is a modern hospital containing 430 beds. It is built on the pavilion system, and consists of eight ward pavilions with the various administrative buildings. The medical wards are on the first floor, the surgical ones on the ground floor. The operating theatres, of which there are four, lie on the north side of the central corridor.

The wards, which are 102 ft. long, 26 ft. wide and 13 ft. high, give the impression of being well-proportioned; they are heated by means of open stoves and hot-water radiators. The windows have double-hung sashes; the lower sash can be raised several inches so as to allow ventilation at the centre without letting a draught through at the bottom. At the top of each window is a hopper with glass sides. The floors are laid with teak blocks, and the walls are lined with tiles to the height of 5 ft., above which they are cemented and painted.

Each ward pavilion contains twenty-four beds in the main ward, and four in the side wards. There is also a day-room for the use of patients. The lavatories and bathrooms are situated at the end of the wards farthest from the corridor; while the kitchen, Sister's room, small wards, day-room, larder, and linen room are at the corridor end.

The children's wards, of which there are four, are 24 ft. wide, and only contain ten cots. The walls are lined with tiled pictures.

The large operating-theatre is octagonal, with a marble gallery running round the wall, at a height of about 7 ft., for students; this gallery is entered from the first-floor corridor. The theatre is lit by a large north window; the roof is of glass, double-glazed; the walls are of white tiles, and the floor of marble terrazzo. There are the usual sterilizing and anæsthetizing rooms.

The lecture-theatre and class-room are immediately below the large operating-theatre, and are large enough to accommodate 100 students.

Professor Morison, the late senior honorary surgeon to the institution, had under his charge one large male surgical ward of 28 beds, half of a large female surgical ward of the same size, and six surgical children's cots, a total of 48 beds. During the year 1913 there were performed 8457 surgical operations.

Mr. Morison attended the infirmary every day in the week excepting Wednesdays. His operation days were Tuesdays and Saturdays, and sometimes Thursdays in addition. He taught students on Mondays or Fridays, but the latter was his principal ward-visit day. His arrangements for clinical teaching on Fridays took the form of allotting to each member of his class one of the large

number of surgical out-patients who were sent to consult him by general practitioners. Students were given a quarter of an hour to make the most of their case, and then the whole class adjourned to a lecture-theatre, the patients, male and female, waiting in adjacent dressing-rooms. In the well of the lecture-theatre is a platform, and this was occupied by Professor Morison, one of the patients, and the student taking that case. The pathological area of the patient was freely exposed, the latter being on a trolley, or a seat, between Professor Morison and the student. The student then gave a diagnosis, which he had to substantiate by stating the symptoms and showing the signs to Professor Morison and the whole class.

A special feature of the ward-visit was the attention Mr. Morison paid to surgical pathology. The pathological specimens from any patient whose case had been the subject of demonstration, were carefully preserved for this Friday class. After the out-patients had been seen, Mr. Morison demonstrated each specimen, recalling the full details of each case.

Visitors are allowed in the area of the theatre, but each must wear a gown without sleeves, a cap and a mask. No special foot-coverings were worn, but the floor was kept damp with a solution of hyd. perchlor. 1–1000.

The patients were anæsthetized in a separate room, wheeled into the theatre, and lifted on to the table by means of a sheet. Anæsthesia was induced in all cases by chloroform first, and then by open ether. This was followed by intra-tracheal ether (Kelly). Mr. Morison remarked that he thought this was the best anæsthesia he had used. It appeared to be safe, abdominal movements were much lessened, post-operative vomiting and bronchitis were less frequent than with open ether, and the shock of operation was diminished.

The instruments, which had been previously sterilized, were kept in 1–40 carbolic, and handed by a nurse. Neither surgeon nor assistants had anything to do with the instruments or ligatures in the trays. After use, the instruments were put into a separate bowl.

Catgut was used on every possible occasion, some of it being extremely thick. It is prepared at the infirmary, being first chromicised by Maçewen's method, then soaked in carbolic, sterilized by boiling in alcohol under pressure, and finally stored in tinct. iodi in alcohol. During the operation it is kept in a tray of methylated spirit. This mode of preparation of the gut had been in use for eight years and had given every satisfaction.

For abdominal cases, especially fat or muscular walls, deep sutures of thick silk soaked in tinct. iodi are often used. These remain in for three weeks, the skin sutures, which are so applied as to bring about perfect apposition, being removed on the tenth day.

Dry sterilized towels were used, a large sheet covering the whole patient and an anæsthetist's screen. For abdominal cases, a wet towel wrung out of 1–40 carbolic was spread over the patient's legs for the purpose of laying instruments on.

The lotions, kept in two basins beside the operator and his assistants, were hyd. perchlor. 1–1000, and normal saline.

The mops used were flat pads of gauze, to which porcelain balls about an inch in diameter were attached by an 18-in. tape, to prevent their being lost. Last year, three patients had come under Mr. Morison's care from other hospitals within a month, with gauzes left in the abdomen. None of them knew why they

were ill, or why their wounds would not heal, and in all mops were removed which had been there for months.

The mops were wrung out of hot normal saline; dry mops were rarely used.

Mr. Morison and the house surgeon both changed their clothes before operating; they wore vests, white trousers, rubber boots, rubber overalls, gowns, caps and masks. The sleeves of the gown were detachable, and were worn with india-rubber gloves covering the lower end. The gloves were wet sterilized, and powdered inside with sterile boracic acid.

All patients upon whom an operation was to be done on one side had the affected side marked with a large cross. Mr. Morison said that mistakes had so frequently been made (he knew of many himself), and the wrong side operated

FIG. 474.

upon, that if the cross was not there the case was sent back to the ward and the house surgeon had to get out of trouble with the patient as best he could.

Preparation of the Skin.—The operation area is prepared the night before with spirit soap, turpentine, and methylated spirit. Just before the incision is made the skin is washed with Harrington's solution, and then with spirit. Before the operation commences, scratches are made on the skin as a guide to the position of sutures (Moynihan). The dressings are sterile gauze wrung out of alcohol, and abundant corrosive wool outside this.

Case 1.—**Inguinal hernia (R. W., aged 20, Cabinet-maker).**

History.—Nine months ago he noticed a lump in the left groin. It had never been strangulated. Suffered from chronic constipation. No chronic cough.

Signs.—Left-sided reducible bubonocele.

Operation.—A 4-in. incision was made over the inguinal canal parallel to a line joining the anterior superior spine to the spine of the pubes. The inguinal canal

was opened by division of the external oblique, and the sac, which was empty, was found and separated from the cord.

After the sac had been opened and separated, it was transfixed above its neck and ligatured twice with thick catgut. The sac was removed, and the stump anchored external to the internal ring by pushing a blunt needle from near the anterior superior iliac spine through the muscles on to a finger in the inguinal canal, drawing the sac sutures through and fixing them to the external oblique. The internal oblique was then sewn down to Poupart's ligament with catgut, one suture passing in front of the outer end of the cord, and four sutures behind the rest.

Mr. Morison pointed out that the most important suture was the innermost, which passed from the conjoint tendon to the inner end of Poupart's ligament, because recurrence was most apt to occur in that situation. The external oblique was sewn up in double-breasted-waistcoat fashion, the lower cut edge being fixed to the posterior surface of the upper flap, and the edge of the upper flap being sewn to Scarpa's fascia over Poupart's ligament. The superficial fascia and fat were united by catgut, so as to obliterate any dead space, and the skin was sewn with subcuticular catgut, two deep sutures of fishing-gut being put in for safety.

Mr. Morison taught that in an operation for inguinal hernia, two groups of vessels and two nerves were encountered, viz., the superficial external pudic and superficial epigastric vessels, and the ilio-inguinal and the genital branch of the genito-crural nerve. The vessels were clamped in Lane forceps, which were taken off before the skin was sutured. If the ilio-inguinal nerve was caught and tied in a suture, this gave rise to considerable and abiding pain; division of the genito-crural nerve caused paralysis of the cremaster, with the result that the testicle hung low and was liable to be squeezed, especially if the man got on to a bicycle or a horse.

Mr. Morison said that most of the patients operated upon in the infirmary for hernia were miners, whose work was extremely arduous, and recurrence was very probable unless a thorough operation was done. His results showed a recurrence in 2 per cent of cases. The worst subjects were not old men, but fat, muscular young men who were growing fatter. The after-treatment was to keep the patient in bed for four weeks, and then allow him to take two weeks' gentle exercise, after which he might return to work.

A dresser was asked by Mr. Morison what were the essentials for a radical cure of hernia, to which he replied: Removal of sac; ligature above the neck; closure of the opening through which it came.

Mr. Morison said that this was the radical cure of abdominal hernia in any situation, but that in the male room had to be left for the cord in the inguinal variety.

Subsequent Note.—The patient returned to show himself six weeks later: scar perfect; all bandages dispensed with. Is to begin his full work in a fortnight.

Case 2.—**Ruptured semilunar cartilage (J. A., aged 39 Miner).**

History.—Eleven weeks ago, while sitting in a coal-mine with knees extended, a fall of coal partially buried him. His right foot was knocked inwards, causing some, but not serious, pain in the right knee, but no joint-locking. He walked home. He also sustained a simple fracture of the right radius and ulna.

One week later he began to have attacks of pain in the right knee-joint, with synovitis; the attacks became frequent. No locking until three weeks ago. This occurred when he was turning over in bed, and caused him acute, sickening pain.

Signs.—Spare; wasting of the muscles above and below the right knee-joint;

tender spot on inner side of patella ligament; no joint inflammation; no urethritis; no other joints involved; *x*-rays show nothing abnormal.

Diagnosis.—Internal semilunar cartilage of right knee-joint ruptured at time of accident; no displacement of fragment until three weeks ago.

Operation.—A tourniquet was first applied, and the knee was then flexed to a right-angle on the table. A vertical incision was made down the inner side of the patella, and then inwards and backwards over the inner tuberosity of the tibia. A blood-vessel crossing the incision transversely about its centre was clamped with Lane forceps before dividing it. This vessel was always seen. The aponeurotic capsule was divided, the synovial capsule opened with another knife, and both were reflected backwards. On acutely flexing the knee the internal semilunar cartilage was seen to be fractured longitudinally and fixed at each end, with the separated band lying between the two condyles and closely hugging the internal one—the bucket-handle variety.[1]

The anterior end of the cartilage was removed from its attachment to the tibia; nearly the whole of the fractured piece, together with the anterior third of the rim of the cartilage, was then excised.

The aponeurotic capsule of the joint, not the synovial membrane, was sewn up with continuous catgut, and the skin in the same manner. In addition, two fishing-gut sutures were used for the skin.

A large dressing was put on, but no splint used. After the bandage had been applied the tourniquet was removed. The dressing was to be left for ten days. The patient was allowed to move the joint when he liked.

Mr. Morison remarked that this was an example of an important class of case, and one to which he had previously drawn special attention from the point of view of employer's liability.

This man's cartilage was fractured by the original accident eleven weeks before.[2] It was not till three weeks ago that the fragment was so displaced as to prevent extension. He had only seen a few of these cases; but if they were not recognized and the man worked afterwards, it was difficult to believe that the disability after such a trifle as turning over in bed could have anything to do with an accident which had occurred previously.

The usual symptoms and signs of a fractured cartilage with displacement were :—

Acute pain which might be attended by an audible crack; locking of the joint; effusion in the joint in a few hours; subsidence of the trouble, with an interval of *complete freedom* from symptoms; recurrence on slight provocation.

Locking of the joint usually meant inability to extend it fully, because the anterior end of the cartilage was generally fractured and displaced; but if the fracture and displacement were posterior, the locking was on flexion.

In the bucket-handle variety of fracture, the joint was not quite normal nor free from uneasiness between the attacks—as in this instance.

Mr. Morison said that he used to sew up the synovial membrane with the capsule, but that the patients often had great pain and distention of the joint. Since he had given up sewing the synovial membrane the patients had been more comfortable.

In all operations he used one knife for the skin, which it was impossible to sterilize, and another for the deeper parts of the wound. He thought a probable reason for the ordinary good results following neglect of this precaution was that individuals were resistant, and had acquired an immunity towards their own organisms which they did not possess towards those from other sources.

Subsequent Note.—Uninterrupted recovery: wound healed by first intention. Left hospital with knee bandaged but without any splint. Later, patient returned to show himself; he can flex his knee so that the calf of the leg touches the thigh. As instructed, he has practised flexing the knee by sitting on a table with the leg over the edge, so that the weight of the leg produced flexion at the knee-joint. Not at work yet.

Case 3.—**Fractured patella (O. T., aged 56, Fitter).**

History.—Is a foreigner. Apparently he "bumped" his left knee against a wooden plank.

On admission.—Hæmarthrosis. Transverse fracture of patella with separation of fragments. Lower fragment quite small. *X*-rays confirm this.

Operation.—A tourniquet was applied around the thigh. A large horse-shoe-shaped incision, convex downwards, was made over the lower part of the knee, and the flap was dissected upwards.

Instruments only were used, no hands touching the wound. The clot was gently removed from the interior of the joint with forceps. No lotion was used in the joint, and no mopping of its interior was done.

The fractured bone-surfaces were exposed, and both were found to be covered with flaps of aponeurosis, which were reflected up and down.

The aponeurosis at the sides, which was torn for about 1½ inches, was then brought together by a figure-of-eight suture of strong catgut, one on each side, and the aponeurosis over the patella was joined to the ligamentum patellæ by one strong catgut mattress suture, which brought the broken fragments into firm and accurate apposition.

The wound was closed by a continuous suture of catgut and two sutures of fishing-gut. No drainage was used. A dressing of spirit gauze, covered with a large quantity of corrosive wool, was applied and the tourniquet removed, after which the limb was placed between two lateral Gooch splints, reaching from the sole of the foot to the perineum on the inside, and the great trochanter to the sole on the outside.

Mr. Morison pointed out that this patient was a very feeble man, much older than his years, and not a good subject for operation: his reason for operation was that no crepitus could be elicited when the fragments were rubbed together, and this meant that the fractured surfaces were covered by the torn aponeurosis, and bony union could not occur. Another definite indication for operation was tilting of the lower fragment, so that its cartilaginous surface faced the fractured area of the upper one.

If the patient had not been so feeble, he would have drilled both fragments and used two catgut sutures to bring them together.

The after-treatment was to keep splints on for six weeks, and then to allow the patient to move his leg for himself. There would be no massage. In less than six months the patient should have as good a joint as ever.

Subsequent Note.—Uninterrupted recovery: wound healed by first intention. Later: firm union of fragments. He can flex the knee to a right-angle. Splints were removed a fortnight ago.

Case 4.—**Chronic gastric ulcer (W. P., aged 38, Tobacconist).**

History.—Has had "stomach" trouble for four or five years.

Pain.—Came on about two hours after meals at first, recently about one hour after meals, occasionally immediately after; worse after a heavy meal; is getting more frequent; worse in winter; has occasionally been wakened up with pain about 2 a.m.

Vomiting.—Has sometimes gone for two days without vomiting and then vomited a large amount (hand-basin full); time varies, sometimes immediately after meals; the vomited matter is usually sour, acid, like frothy yeast, and foul-smelling; always relieves the pain, usually gives complete ease; sometimes self-induced; has been getting larger in amount.

Blood.—One attack of hæmatemesis (coffee-ground) previous to admission; no melæna before admission; has lost over two stone in last four years.

On Admission to Medical Ward.—Emaciated and anæmic; since admission had two attacks of severe hæmatemesis, and almost constant melæna. He is now on rectal feeding.

Signs.—Rigidity of both upper recti muscles, with epigastric tenderness; stomach dilated, the greater curvature being well below the umbilicus; visible peristalsis seen; the vomit was coffee-ground in character, alkaline, sour-smelling, and frothy; it contained free HCl and, microscopically, sarcinæ and yeast fungi were seen; hæmoglobin, 50 per cent.

Diagnosis.—Active pyloric ulcer adherent to pancreas, with stricture; dilated stomach.

Operation.—Median incision to below the umbilicus (which was excised by an elliptical incision). The stomach was found to be much dilated, and a large cicatricial œdematous mass occupied the region of the pylorus. This was adherent to the gall-bladder above and to the pancreas behind. The appendix was found to be kinked and adherent; it was removed. No Lane kink was present. A posterior gastro-enterostomy was done without clamps by the no-loop (Moynihan and Mayo) method. A large opening about 3½ in. long was made, so as to allow for subsequent contraction of the stomach. The pylorus was occluded and depressed by a running silk suture on the anterior surface of pylorus and duodenum, so as to obliterate the outlet and to form a thick pad.

The wound was closed in layers with catgut sutures and some deep sutures of strong silk soaked in iodine. A large dressing of wood-wool was applied. The patient was infused intravenously during the operation.

It was not sufficiently recognized, Mr. Morison stated, that division of a muscle, if properly sutured and if its nerve were not damaged, left no disability. He had divided the rectus femoris above the knee-joint on several occasions, and had found that after healing the divided muscle was as strong as that on the opposite side.

Mr. Morison remarked that there were only two ideal abdominal incisions—one in the middle line, and the other oblique, parallel to and avoiding the nerves of the abdominal wall. When properly sutured, these incisions could be relied upon not to allow of a subsequent hernia, and they were the only ones of which that could be said. The worst incision was one in the semilunar line, and especially below. On five or six occasions he had operated on cases of ventral hernia after this incision had been made, and which were due to it. They were difficult cases to cure, because nerve-division had made the muscles yellow, fragile and flaccid.

He believed in a large incision in these cases, so that a thorough examination of the abdominal viscera could be made. In one of his early cases, when he made small incisions, he did a gastro-enterostomy for a stomach ulcer, although he noticed at the time that the jejunum was dilated. He did not explore further to discover the cause of this. The patient was not relieved and soon died. Post mortem it was found that he had a stricture of the jejunum two feet from the duodeno-jejunal flexure, the result of an old stab in the abdomen.

Later he had two similar cases of dilatation of the jejunum. Both were due to stricture, and multiple peritoneal nodules were present in both. One was

tuberculous and one malignant. This was proved by microscopic section of removed nodules. In these cases he did a gastro-enterostomy below the stricture. In the malignant case he saw the patient six months after the operation, and she appeared then to be very well. Presumably she died soon after, for he had not seen her again. The tuberculous case quite recovered.

He did not know what dilatation of the duodenum meant, as he had never been able to find any cause. It was common in the miserable people dubbed neurotic, who were the curse of surgeons.

Mr. Morison pointed out that the patients who had pain in the early hours of the morning usually had—as in this case—an ulcer, either gastric or duodenal, adherent to the pancreas.

He believed in a large dressing of wool, as it kept the patient warm, and allowed of comfortable compression and some distention without severely tightening the bandage. In cases like this, where there had been considerable hæmorrhage, acute dilatation of the stomach was very liable to occur, and quite suddenly, even so long as two weeks after operation. If it were not recognized, the so-called vicious-circle vomiting developed and the patient died. Early recognition, followed by stomach lavage, usually worked a miracle. The patient was immediately restored, and as a rule required no further washing out.

This patient was infused intravenously owing to an increase in the pulse-rate. His general rule is that if the blood-pressure falls below 100 during the operation, or the pulse rises above 100, the patient should be infused.

He had never used clamps for gastro-enterostomy, being deterred by fear of hæmorrhage into the stomach after the operation. He liked to cut and tie the bleeding vessels and feel safe. It would be wrong to say, when surgeons, much better qualified than himself to offer an opinion, advocated and used clamps, that this was a mistake, even if he thought so. The clamp operation was easier and cleaner, but as none of his patients had died of peritonitis after the operation, he thought that careful packing could prevent this. This was the ninety-eighth case since 1911 on which he had done gastro-enterostomy for simple ulcer and its complications, and of these only one had died, from hæmorrhage ten days after the operation. That patient had multiple ulcers in the stomach and duodenum. It was worth noting that during this time, at least three patients, apparently no worse than many of those operated upon, had died suddenly the day before that fixed for operation, so that he was fortunate in his statistics this time!

Subsequent Note.—Uninterrupted recovery; never vomited after operation; was eating minced beef without any pain or discomfort after tenth day; wound healed by first intention.

Case 5.—**Abdominal pain regarded as gall-stone colic (G. S. aged 33, Housewife).**

History.—For ten years had suffered from abdominal distention after a heavy meal. Attack of acute pain fourteen days ago. Gradual onset in bed, with pain in lower abdomen; it became acute, made her shout and shiver, but she did not vomit. It did not catch her breath. The acute pain lasted for about twenty-four hours; it gradually went away, but was replaced by soreness.

Thirty-six hours after onset of the first attack she had a further acute attack. Sudden onset, with acute pain in right hypochondrium, radiations to right. Caught her breath. Lay still in bed; dare not move. No vomiting. Acute pain replaced by right hypochondrium soreness.

Never been jaundiced; no urinary frequency; had had epigastric pain immediately after food; no hæmatemesis, or melæna.

On Admission.—Spare.

Signs.—No jaundice; tenderness over gall-bladder; *x*-rays show no abnormal shadows in the gall-bladder and renal areas.

Diagnosis.—Gall-stones; cholecystitis.

Operation.—A transverse incision was made midway between the costal margin and the iliac crest, and the abdomen was opened through the oblique and transversalis muscles. In this case the sheath of the rectus was divided, but not the muscle. It was rarely necessary, Mr. Morison said, to divide the muscle.

For this incision the patient was bent laterally, so as to open up the space between the costal margin and the iliac crest. The pouch between the liver above and the transverse mesocolon below was opened up and packed with a large gauze mop.

No stone was found in the gall-bladder, which appeared to be, and felt, normal. The appendix was found to be kinked and thickened at the end. It was removed and found to contain some fæcal matter. The mucus membrane was swollen. No Lane kink was present, and nothing was found wrong in pelvis, kidneys, or ureters. The stomach was reddened and the duodenum was much dilated, but no cause for this was found.

Mr. Morison could not explain the condition; but he felt pretty certain that although the appendix had been removed, this was not the cause of her trouble. It was an unsatisfactory class of case, and one not at all likely to be benefited by surgical treatment.

He had introduced this transverse incision many years ago, and had frequently advocated it. So far as he knew, no other gave such a good exposure of the biliary tract, or made operations upon it so easy and safe. He only used the longitudinal incision through the rectus when the diagnosis was not clear and gastro-enterostomy might be needed.

The muscles were united in two layers by catgut sutures and some deep sutures of silk soaked in tinct. iodi. If the gall-bladder had to be drained, the tube was brought out at the posterior end of the wound. The gall-bladder was never sewn to the parietal peritoneum in his cases.

Subsequent Note.—Uneventful recovery: wound healed by first intention.

Case 6.—**Epithelioma of lip (T. W., aged 60).**

On Admission.—An epitheliomatous ulcer at the left angle of the mouth and a mass of large malignant glands in the corresponding side of his neck.

Mr. Morison said that, as a rule, malignant ulcers of the face were unusually benign, but that those at the angle of the mouth were an exception, and possessed a malignancy equal to those of the tongue.

Operation.—He first did a "block dissection" (Crile) of the neck, by one incision extending from the mastoid process to the clavicle at the back of the sterno-mastoid muscle, and a second from the point of the chin to the centre of this.

After reflecting the skin-flaps, he divided the sternomastoid above and below, and excised the fat and lymphatics with the internal jugular vein and the separated muscle. Then the external carotid artery was ligatured between the lingual and facial branches, and the cheek-growth was freely excised.

The neck wound was closed with catgut interrupted sutures (to allow of drainage), no drainage-tube being used.

Subsequent Note.—Good recovery: wound healed by the time he left hospital, a fortnight later.

REFERENCES.

[1] Injuries to the Semilunar Cartilages of the Knee. *Clin. Jour.*, 1913, April 9.
[2] *Lancet*, 1909, Feb. 27.

A VISIT TO THE CLINIC OF PROFESSOR GARRÉ AT BONN.

THE Hospital is charmingly placed amid park-like grounds gently sloping down to the Rhine. The different buildings are separated from one another by pleasantly-shaded walks among shrubberies tenanted by nightingales, and from the balconies of the Frauenklinik, situated nearest the river, may be obtained a wonderful view stretching away to the blue hills on the farther side of the Rhine.

Two of the buildings, connected by a covered way, comprise the surgical department; and here is to be seen Garré, Professor of Surgery in the University of Bonn, and Director of the Surgical Clinic.

In order to understand the relationship of these two posts, it is well to explain that in Germany all universities are state institutions. They do not belong to the Empire, but to its several constituent States, such as Prussia, Saxony, Baden, etc. The hospitals, on the other hand, are as a rule supported by the municipality, except in Prussia, where both universities and hospitals belong to the State. But where a hospital, run by the municipal authorities, is located near a university, there exists some form of contract to define their relationship and provide facilities for teaching. So it comes about that the professor of surgery is generally director of the surgical clinic in the hospital.

FIG. 475.

Garré's clinic comprises 150 beds, operating and demonstration theatres, an out-patient department, and pathological, *x*-ray and experimental rooms.

He works here with twelve assistants, six of whom are volunteers selected from among his senior students. Prof. Machol is the senior assistant, and has general supervision of the administrative and surgical work. The other assistants have each certain duties allotted to them, either the care of a specific number of beds or the charge of one of the out-patient departments.

Patients receive first-, second-, or third-class accommodation in the hospital, according to their means. For first-class patients there are 16 beds, each in a separate room, where ten shillings a day is charged. For six shillings a day patients may obtain a bed in a small ward with two or three others; while

even the third-class patients pay a small sum, generally contributed from the funds of the state insurance, or Krankenkasse.

Garré has also control of another hospital of 150 beds, which is not affiliated to the university.

The new operating theatre in the clinic is large, well-lighted and ventilated, with white-tiled walls and terazzo floors. Opening out of it are several small rooms for sterilizing dressings and instruments, and anæsthetic and recovery rooms.

The wards are generally medium-sized, containing twelve beds. They are clean and airy, and nicely decorated.

So much for the environment: as for the man himself, no one who has had the privilege of seeing him at work will deny that he is a worthy successor of Bier and Trendelenburg.

A surgeon may be judged by the way he discharges his full duty to science, education, and humanity. Measured by these standards, Garré is worthy of a high place among the men of our day. He is an acute investigator, a close observer, and an honest recorder; his scientific contributions are therefore worthy of earnest attention.

He himself says his life's work is teaching, and however faulty may be the German demonstration lecture as a basis of clinical instruction, Garré reaches a high level of fluent brilliancy in his masterly presentation of a case.

As an operator he is painstaking and thorough, and concerned only with his patient's welfare.

The details of the operating-room technique are mainly on the orthodox aseptic plan, though face-masks and rubber gloves are not worn. The hands are prepared with soap and hot water, followed by 70 per cent alcohol; gloves are worn as a protection in septic cases only. Iodine is used for the preparation of the patient's skin. Fine silk alone is used as a ligature and suture material.

As regards anæsthesia, Garré prefers general narcosis (ether or Billroth mixture on an open mask) to local analgesia, though the latter is frequently used in his clinic.

Three goitre operations were witnessed: one under general (ether) anæsthesia, and two under local analgesia. One of the latter was a simple goitre, the other two were associated with hyperthyroidism. The operations were performed through transverse incisions dividing the sterno-laryngeal muscles transversely. After exposure of the lobe, the superior thyroid vessels were first ligated and divided, the gland was then dislocated forwards while the middle and inferior vessels were secured, and finally the isthmus was cut across with scissors. At each pole of the gland the vessels were very clearly exposed before ligature.

During the dissection a pair of closed blunt-pointed scissors were much used. The wounds were closed without drainage.

In one case, several adenomata were enucleated from one side after excision of the opposite lobe. In this case also there was no drainage.

In the diagnosis of hyperthyroidism, Garré lays stress on the following symptoms in the order given: the blood picture, musculature, wasting, intestinal symptoms, exophthalmos. He believes that many of the symptoms are due to the enlargement of the thymus which is so often found, and he has come to think that thymectomy is the operation of choice in such cases. This is done through

a transverse incision above the upper border of the sternum. The fascial envelope of the thymus is opened, the gland is caught as it rises into the neck during expiration, and is slowly and gently drawn up while stripping it with gauze. Photographs and specimens were shown from several cases in which this operation had been done after the failure of thyroidectomy to give the expected relief. The results appeared to be good.

On another occasion, Garré showed cases illustrating the results of the surgical treatment of tuberculosis of the knee- and ankle-joints. He believes in early astragalectomy in tuberculosis of the ankle-joint, and has obtained good results in 75 per cent of 79 cases from five to ten years after operation. The excellent functional result seen in the cases shown is attributed by Garré to the tilting of the os calcis so that its anterior surface comes to articulate with the lower end of the tibia, thus compensating for the shortening, and preserving the elasticity, of the foot.

The knee is the only other joint which Garré holds should be excised early when afflicted with tuberculous disease. This opinion is based on an experience of 268 resections of the knee, where 92 per cent were cured of the disease and 83 per cent showed a good functional result. Three of these cases were shown, and they appeared to suffer very little disability from their stiff knees.

For the purpose of filling up bone cavities, Garré employs a plug of subcutaneous fat. This method has been worked out by Dr. Makas, one of his assistants, in the surgical laboratory, and he exhibited a series of specimens from the tibiæ of dogs, showing that the fat was apparently converted into a scaffold of fibrous tissue which was replaced later by new bone. Two cases were shown in which the method had been used. One was a girl operated on two years ago for what was thought to be tuberculous disease of the os calcis. The hollow left in the bone after gouging away the disease was filled with subcutaneous fat. As a matter of fact the disease proved to be myeloid sarcoma, but there had been no recurrence. The other case was that of a girl whose knee had been resected two years ago for tuberculous disease; at the same time a cavity in the upper end of the tibia was scraped out and filled with subcutaneous fat. The wound healed by primary union. Skiagrams of these two cases showed the cavities filled up by bone.

A very interesting case was a man with carcinoma of the pharynx and larynx, upon whom Garré performed hemi-laryngectomy. The operation was satisfactorily achieved under local regional anæsthesia with ½ per cent novocain. After splitting the thyroid cartilage and painting the interior of the larynx with cocaine, it was found that the disease originated in the right sinus pyriformis and had involved the larynx secondarily, invading also the cricoid. It was necessary, therefore, to resect a portion of the hypopharynx and upper opening of the œsophagus, together with the right half of the larynx. After the outer surface of the right half of the larynx had been completely isolated, it was severed from the trachea below and removed with the adjacent portions of hypopharynx and œsophagus.

The cut edge of the œsophagus was sutured to the muscles on the right side of the wound; in doing this, the lumen of the œsophagus was accidentally closed, and Garré found that he was unable to pass his finger from the pharynx into the œsophagus, though at the moment the cause of this was not clear.

This error provided the most interesting feature of the operation, for it brought out the individuality of the operator. Steadily and methodically he sought to rectify the mistake until, by loosening the sutures, he found the way was clear. The sutures were then correctly placed, and a large metal tube introduced into the trachea.

The operation was completed by inserting tamponades of iodoform gauze, one in the mouth to be changed twice daily, and one below this, resting against the tracheal tube, not to be removed before the fourth day. The upper part of the wound was sutured ; its lower part, through which emerged the tracheal tube and the end of the lower gauze plug, was to be sutured at the end of six days.

Garré also performed two operations on the gall-bladder. The first case had been diagnosed as carcinoma ; an old woman, deeply jaundiced, with no history of pain, colic, or vomiting. Some ascitic fluid escaped on opening the abdomen ; it was then found that the stomach and colon were densely adherent in the region of the gall-bladder, and a hard collection of glands was felt posteriorly. Behind the adhesions was a cystic mass which was proved to be gall-bladder by the aspiration of bile and mucus. A cholecysto-gastrostomy was performed with a single row of interrupted silk sutures, reinforced in front by omentum.

The other case was that of a stout woman complaining of sudden attacks of epigastric pain and vomiting. The abdomen was opened by a vertical incision through the outer edge of the right rectus. The gall-bladder was large and easily delivered into the wound. After separating adhesions, the cystic artery and cystic duct were separately tied and divided, and the gall-bladder removed. The bed of the gall-bladder was buried by suturing the peritoneum across it, and the stump of the cystic duct was carefully covered in. The wound was closed with continuous silk suture and the dressings affixed with adhesive plaster. The gall-bladder contained mucus and many gall-stones.

It is interesting to observe how Garré spares himself while operating. He makes an incision and then stands aside while the assistants control the bleeding ; and at the close of an operation, when the delicate work is done, the patient is handed over to an assistant to be sutured. Though a little thing, this is worth noting, for it is typical of the idea which underlies the whole system of German surgery—the one controlling hand to which all others are subservient : an organization directed by the influence of one man.

A description of Garré's clinic would be incomplete without reference to his work as a professor, for though one's attention is naturally chiefly directed to his methods of diagnosis and treatment, yet the impression that lives in the memory is that of an earnest teacher, clad in white overalls, surrounded by tier upon tier of attentive students, who watch him skilfully unfold a diagnosis and with sure touches paint a picture of disease from the inert patient lying in the amphitheatre. There is nothing theatrical about it ; his power as a clinical teacher lies in his simple earnestness and sincerity.

A REVIEW OF THE PRESENT POSITION OF SURGICAL TREATMENT OF EXOPHTHALMIC GOITRE.*

By JAMES BERRY, London.

Much discussion has taken place in the last few years as to the desirability or otherwise of operating for the disease known as exophthalmic goitre. The literature of the subject is already so vast that I feel some hesitation in acceding to the request that I should contribute to these pages an article on the present position of this difficult and complex subject. Recent researches into the pathology of the thyroid gland, improvements in operative technique, and especially the accumulated experience of clinicians, both medical and surgical, as regards the selection of cases for operative treatment, have led me to modify to a certain extent the views I formerly held. There is certainly more to be done for exophthalmic goitre by surgery than seemed possible only a few years ago. On the other hand, it has of late been too readily assumed by some of those who have not themselves had occasion to operate for goitre to any large extent, that the matter is more simple than it really is. One sometimes hears the opinion expressed that operations for exophthalmic goitre are no more serious than those for simple goitre. One writer, whom I quoted last year in my Lettsomian lectures, seemed to think that it was only necessary to operate " with delicacy " to cure practically all cases of exophthalmic goitre. The subject is in reality far more complex than this optimistic attitude of a physician would imply.

At the outset of any enquiry into the subject we are met with the difficulty of correctly defining this term. What do we mean when we speak of an exophthalmic goitre? An ordinary *typical* case presents the symptoms of *exophthalmos, goitre, tachycardia,* and *tremor.* In the diagnosis of these cases there is no difficulty. Nor is there much, if any, difficulty in predicting the pathological condition in which the gland will be found, either post mortem or after removal by operation; the thyroid will always show marked hyperplasia; there will be a diminution in the amount of colloid stored up within the gland, and an increase in the epithelial constituents. The diminution of colloid and the hyperplasia appear to be directly proportionate to the severity and acuteness of the clinical symptoms.

Between the normal thyroid, however, and the thyroid of a typical case of exophthalmic goitre, there are numerous intermediate forms in which the essential pathological changes are varied and incomplete. And just as the pathological picture may be incomplete or atypical, so also may be the clinical aspect of the case. There may be no exophthalmos. There may be no visible or palpable thyroid gland, either because the enlargement is so slight

*I am indebted to my colleague, Mr. C. A. Joll, for kind help in the preparation of this article.

as to escape detection, or because the gland is so deeply seated at the root of the neck or within the thorax that it cannot be felt. Yet the gland will always be found to be diseased. There is no reason whatever to suppose that the clinical symptoms of Graves's disease are ever associated with a normal thyroid gland. A true exophthalmic goitre always shows some hyperplasia. Whether the converse is also true, viz., that hyperplasia of the thyroid as seen by the pathologist can of itself always be taken as evidence of Graves's disease, is at least somewhat doubtful. In many goitres unaccompanied by the ordinary symptoms of Graves's disease, small local areas of hyperplasia may be seen; these are familiar enough to anyone who has had much operative or pathological experience of the disease. A thyroid gland which has undergone much cystic or other degeneration is especially likely to contain such areas of hyperplasia, which may be regarded as compensatory in nature. The pathological appearances of compensatory hyperplasia, such as that which occurs in one lobe of a gland after removal of the opposite side, are well known to simulate very closely, if not indeed to be absolutely identical with, those of Graves's disease. Yet in these cases clinical symptoms of the disease do not necessarily occur. Certain conditions of inflammation of the thyroid, too, may present a pathological appearance difficult to distinguish from that of Graves's disease.

The atypical forms of the disease to which the terms, "formes frustes," incomplete Graves's disease, etc., have been applied, have been the source of much confusion in the compilation of statistics and in the deductions drawn from them. One author will use the term "exophthalmic goitre" only in the stricter sense of a goitre with exophthalmos and other associated symptoms. Another will include in his statistics cases without exophthalmos, even those of simple cyst or adenoma accompanied by, as is not infrequently the case, a certain amount of tachycardia, palpitation, tremor, and various other nervous symptoms. He considers, perhaps truly enough, that the disease is of the same essential nature in all; but the two classes of case generally differ widely in seriousness both as regards prognosis and in the danger of operative treatment. Before we can make use of statistics of exophthalmic goitre, it is necessary that we should understand clearly what type of case is included.

It would, perhaps, be advantageous to abandon the term exophthalmic goitre, and use some common name which would include all forms of the disease. The term hyperthyroidism is probably less open to objection, although its use implies the acceptance of a theory which, while probably correct, cannot as yet be said to be thoroughly and indisputably established, namely, that hypersecretion of the gland is the essential cause of the clinical manifestations.

The somewhat cumbrous name thyreotoxicosis, favoured by Kocher, is perhaps a better one, implying that the disease is a poisoning by thyroid secretion. It does not imply that the secretion is necessarily increased in quantity, as does the more common term hyperthyroidism. There may be more secretion, but it may perhaps be abnormal in quality rather than in quantity.

Whichever term be employed, the modern surgical treatment of exophthalmic goitre is based upon the assumption that Graves's disease is due to a poisoning by thyroid secretion. It is true that there are still a few clinicians who hold to the ancient view that it is the nervous system that is primarily at fault, although their number is yearly growing less.

Dr. Louis B. Wilson has recently published an admirable summary of the relationship of the clinical and pathological aspects of exophthalmic goitre. His work is based upon the large amount of material afforded by the Mayo Clinic of Rochester, Minnesota, where well over a thousand cases of exophthalmic goitre (the term is used in its wider and more comprehensive sense) have been studied by him from the pathological side, and by his medical colleague, Dr. Plummer, from the clinical side.

The essential factors in the hypothesis that has enabled Wilson and Plummer to show that there is a distinct relation between the clinical and pathological pictures of exophthalmic goitre (in the wider sense in which they employ the term) are briefly stated thus by Wilson :—

1. The thyroid gland is composed almost wholly of secreting tissue.
2. Anything which is made by the gland must get into the circulation before it can affect distant parts.
3. The thyroid gland is also capable of storing up material.
4. Certain symptoms of exophthalmic goitre—symptoms of pressure on the trachea and adjacent vessels and nerves—are due to increase in size of the gland, largely from its over-filled storage capacity.
5. Certain other symptoms of exophthalmic goitre—the acute toxic symptoms—seem due primarily to something made in the thyroid gland which passes into the general circulation, and acts directly on distant vital organs.
6. Yet other symptoms of exophthalmic goitre are the secondary result of: (*a*) Degenerative changes produced in distant organs after their affection by thyroid secretion; and (*b*) Disturbance of the normal inter-relations of these organs themselves.*

INDICATIONS FOR OPERATION—SELECTION OF CASES.

There is little doubt that many of the bad results which have prevented physicians from recommending, and surgeons from performing, operations for exophthalmic goitre, have arisen largely from want of knowledge in the proper selection of cases for operation, and especially of the period at which operation may be most safely undertaken.

Dr. Plummer, speaking from his experience of cases in the Mayo Clinic, considers that symptoms of exophthalmic goitre generally develop rapidly and reach a maximum about the end of the first year. During the last six months there is generally vomiting and diarrhœa, pointing to acute intoxication, and at the end of the year about 75 per cent of the patients have dilatation of the heart. After this period there is generally a fall in the severity of the symptoms, and by eighteen months the cases of dilated heart have fallen to 6 per cent. By the end of the second year, however, the percentage has again risen to 75 per cent.

He considers that the time to select for operation is either at a very early period, before the first rise, or else during the first half of the second year. Symptoms of acute toxæmia, such as diarrhœa, vomiting, and much dilatation

* "The Relationship of the Clinical and Pathological Aspects of Exophthalmic Goitre." Read before the Second Tri-State Medical Meeting of Washington, Idaho, and Oregon, Portland, Ore., July 5–6, 1912. Reprinted from *North-West Medicine*, 1913, Jan., pp 1–5, in Collected Papers by the Staff of St. Mary's Hospital, Mayo Clinic, 1912. Pub. W. B. Saunders, 1913.

of the heart, are contraindications; in these cases a period of rest should be enjoined, and the patient kept under observation. Rest will benefit the heart, but it does not seem to affect the incidence of the curve marking the rise and fall of intoxication. When death occurs after operation, it is generally due to its having been performed while the patient was severely intoxicated, or else, if performed at a later stage of the disease, from failure of the heart owing to the effect of long-continued, though less acute, intoxication.

These remarks embody sound ideas, both as to the class of case suitable for operation and the time at which it should be undertaken. With regard to *very* early operation, I cannot, at present at any rate, bring myself to recommend this in the very earliest stages of the disease, because in many cases good results do follow medical treatment. The disease may, and often does, wear itself out spontaneously.

In the case of patients who show symptoms of acute intoxication, such as vomiting, diarrhœa, glycosuria, much nervous excitement, marked cardiac dilatation, much irregularity of the heart and extreme tachycardia, the risk of operation is great. It is probably better in such cases to defer operation, the patient being watched and kept under medical treatment in the hope that, as not infrequently happens, the symptoms will become milder.

Long-standing cases, where irremediable secondary degeneration is present, are hopeless from the point of view of cure, and if any operation be attempted for the relief of the condition it will necessarily be attended with considerable danger to life. One cannot say, however, that such operations ought never to be attempted, as sometimes much alleviation is the result. I know no class of case where it is more difficult to decide whether operation is justifiable or not. An operator who thinks most of his statistics will rigidly exclude all these, while one who thinks chiefly of his patient will sometimes consent to operate at the instance of a patient who is willing to run even considerable risk if there is a good chance of relief from very distressing symptoms.

THE CHOICE OF OPERATION.

Acting upon the probably correct assumption that the essential cause of the disease is a poison manufactured in the thyroid gland, the modern surgeon seeks to diminish the quantity of that poison by cutting off a part of the source of supply. This may be done by:—

1. *Removal of a portion of the gland.*
2. *Ligation of one or more of the thyroid arteries*, thus cutting off some of the blood-supply to the gland.

Besides these two main operations, there are several others which are deservedly falling into disrepute and of which but little need be said. These are exothyropexy and the various operations upon the sympathetic nerve.

Exothyropexy consists in the luxation of the gland through an incision made over it, exposing it to the air, and leaving it gradually to contract and shrivel up. This takes place in the course of a few weeks to a few months, if the patient is fortunate enough to escape the manifest danger of sepsis. The operation can be performed only if the goitre is prominent and of considerable size: it is certainly dangerous, and the cosmetic result leaves much to be desired. It

has never found favour in this country and has little or nothing to recommend it.

The operations upon the cervical sympathetic consist in division or resection of the main sympathetic trunk of the neck, with or without excision of one or more of the cervical ganglia. Although I have never myself performed this operation, I have seen it performed, and have witnessed a death within a few hours as the direct result. It is not an easy operation, and is probably quite as severe as removal of half the gland; it again is not to be recommended.

Operations upon distant parts of the body, such as the nose, the appendix, or the ovary, appear occasionally to have been followed by amelioration in the symptoms of the thyroid disease. Their effect, however, is uncertain and ill-understood, and at the present day few surgeons would choose such methods in preference to a direct attack upon the thyroid.

We return therefore to the two main operations of choice, excision and ligation.

1. **Partial Extirpation.**—Theoretically, complete removal of the gland might be supposed to give the best results. But as the thyroid is an organ necessary for health, if not for life itself, complete removal is inadmissible. Although to a certain extent the function of the thyroid can be replaced by the artificial administration of its secretion by the mouth or by transplantation of thyroid tissue, such methods cannot be relied upon. It is not necessary, and it is certainly dangerous, to perform complete removal.

How much gland should be removed in a given case?

This depends largely upon the severity of the case, and the individual experience, judgement and skill of the operator.

The easiest and safest operation is removal of one half of the gland. Some operators of large experience, notably Mr. Dunhill, of Melbourne, consider that the operation of choice should be the removal of one lobe, together with half the remaining lobe. Most operators would agree, however, that interference with the second lobe as a rule involves too much risk. It is my own opinion that the operator, at least in his earlier cases, had much better be content with unilateral extirpation. Removal of one lobe can be performed by a skilled operator with comparatively little loss of blood. The superior thyroid vessels, and the middle and inferior thyroid veins, should be tied in their continuity. The inferior thyroid artery should either be tied in its continuity, or its branches should be tied well in front of the recurrent nerve. The vessels of the isthmus, which are found chiefly along its upper and lower borders, should be clamped with forceps before being divided; or if the isthmus be small, it may be grasped in a long pair of forceps and tied in a single ligature. It is from small unnamed vessels that most of the hæmorrhage in such an operation takes place. The greatest care should always be taken to secure bleeding points with forceps at once, so as to minimize the hæmorrhage to the utmost extent.

If the operator proceeds to remove a portion of the opposite lobe, he must cut across the gland substance. This involves hæmorrhage from the cut surface, the oozing from which may be most difficult to control, and the patient may easily lose more blood than is desirable.

If the operator be not content with removal of one half of the gland, but

at the same time is unwilling to remove more, he may sometimes with advantage tie the vessels of the upper pole of the opposite lobe, which will involve scarcely any additional loss of blood.

Removal of one lobe, together with ligation of both the opposite thyroid arteries, can scarcely be recommended, as it would involve too much risk of tetany or myxœdema.

2. **Ligation of Thyroid Arteries.**—Ligation of either superior or inferior thyroid artery may be performed, but in practice ligation of the inferior is seldom desirable, since it is usually a difficult operation, involving a deep dissection in the neck.

Ligation of the superior thyroid is an excellent operation. It is much less severe than removal of a lobe. It may therefore be recommended as a preliminary proceeding for cases in which it is doubtful whether the patient's general condition is sufficiently good to allow of the performance of the radical operation of partial thyroidectomy. It is especially useful in the case of a thin subject with a large goitre. In such cases, ligation is generally an easy, while partial thyroidectomy may be a severe, proceeding.

Ligation may be performed upon one side of the neck only, or upon both sides at once through a single incision.

If there is any doubt about the ability of the patient to stand a double ligation, it is much better to be content with operation upon one side only. Dr. Charles Mayo, who has had a very large experience of ligation, considers that the reaction after ligation of one superior thyroid artery is about three-fourths as severe as bilateral ligation, but that the missing fourth is an element of safety. The subsequent ligation of the opposite artery a week or two later is a much less severe proceeding.

Method of performing ligation of the superior thyroid artery.—An incision is made, running outwards and slightly upwards, from near the middle of the thyroid cartilage, crossing the upper pole of the gland. After division of the platysma and cervical fascia, and ligation of any veins that may be present in the wound, search is made for the omo-hyoid muscle, at the outer border of which the superior thyroid vessels will be found. The great cornu of the hyoid bone and the superior pole of the gland are also good guides to the position of the vessels; the latter are close to the apex of the gland on its inner side. It is best not to isolate the artery, but to apply a single ligature to artery, vein and lymphatics. The apex of the gland itself may often with advantage be included in the ligature. Care should be taken to include, if possible, the posterior branch which is often found running down the back of the apex of the gland. After every bleeding point has been carefully secured, the fascia and platysma should be sewn up with a fine continuous catgut suture, and the wound closed without drainage. The chief difficulties of the operation are the presence of superficial veins and the inconstant position of the vessels, to which there are no very exact guides. All exposed veins should be immediately clamped and tied as the dissection proceeds, lest infiltration of the tissues with blood should obscure the later stages of the dissection. The exact position of the artery necessarily depends to a certain extent upon the size of the enlarged gland. If there is any doubt as to the position of the apex of the gland, the patient should be asked to swallow. The

movement of the gland then renders its recognition easy. If performed, as it usually should be, under local analgesia with novocain and adrenalin, the operation is almost bloodless, and should not take long in its execution.

As mentioned above, ligation of the inferior thyroid artery is not to be recommended, on account of the greater severity and difficulty of the operation. If performed at the anterior border of the sternomastoid muscle, numerous vessels have to be divided and the lobe of the gland turned over before the artery can be reached. If the isthmus be thick and the gland firm, as it often is, there may be great difficulty in effecting this. In fact, the severity of the operation may be quite as great as that of removal of an entire lobe.

Ligation through an incision in the posterior triangle of the neck avoids the necessity of dealing with middle thyroid veins, but involves a deep and difficult dissection.

Ligation compared with Partial Thyroidectomy.—It has been objected by some that ligation is not a satisfactory operation. It can deprive the thyroid gland to a small extent only of its blood-supply; the cutting off of the source of the thyroid poisoning is therefore very limited. It is an operation which, even if confined to the ligation of a single superior thyroid, is not wholly free from risk; death has been known to occur even after ligation of one such artery.

On the other hand, it can scarcely be doubted by anyone who has had much experience of both ligation and thyroidectomy for true exophthalmic goitre, that ligation of one superior thyroid artery, though it produces much less curative effect upon the disease, is really a very much safer operation. It can often be performed with comparatively little risk in a case in which partial thyroidectomy would involve grave danger to life. Although its immediate curative effect may be comparatively slight, yet it does seem to do something to render subsequent, and perhaps more radical, interventions much safer. Allusion has already been made to the undoubted fact that ligation of a second superior thyroid is a much less severe proceeding than that of the first. Similarly, a preliminary ligation of one or both superior thyroids does seem to diminish materially the risk of a subsequent thyroidectomy.

A comparison between the mortality-statistics of ligation and partial thyroidectomy is of little value, since it is precisely in the worst class of cases, those in which thyroidectomy is considered to be too dangerous, that ligation has its greatest value, and is most likely to be performed.

It is valuable also as a measure of the susceptibility of the patient to operative interference. The benefit that may result from a double ligation, even if not followed by the more radical operation of thyroidectomy, is often most striking.

Like thyroidectomy itself, it is of least value in cases of long standing, in which the symptoms are due less to active thyroid intoxication than to the permanent degenerative changes in the heart and other viscera that have been induced by the long-continued action of such intoxication.

The Rôle of the Thymus in Graves's Disease.—During the last five years a great deal has been written on this subject, yet it does not seem possible

to define very accurately the relationship between the two glands in this disease.

Joffray[1] claims that persistence of the thymus is a constant feature of exophthalmic goitre, Thorbecke[2] and Capelle,[3] in 36 cases, confirmed this, while Rendu[4] goes so far as to say that all the bad effects (including death) after operation for exophthalmic goitre are due to the persistent thymus.

Gebele[5] holds very much the same views, and suggests that thymectomy should precede thyroidectomy in all cases of Graves' disease, and Zesas[6] supports this contention.

Garré[7] holds that thymus hyperplasia is the primary cause of Graves's disease, rather than the thyroid, and von Haberer[8] claims good results from thymectomy in the treatment of the disease.

Melchior[9] and Lenormant,[10] while admitting the frequent co-existence of enlarged thymus and Graves's disease, refuse to believe that the relationship is of great importance. It seems to me that the evidence brought forward so far is too meagre to permit of any useful generalization as to the pathological connection between the thymus and Graves's disease, although there can be but little doubt that enlargement of the thymus does occur in all well-marked cases. Anyone who has examined the thymus repeatedly at autopsies would hesitate to attempt the removal of a gland which is often intimately adherent to the great vessels in the superior mediastinum, and which may extend to the lower end of the pericardium, unless the value of that operation had been unequivocably demonstrated.

WHAT ARE THE SPECIAL DANGERS OF OPERATIONS FOR GRAVES'S DISEASE?

We will put aside for the present all incomplete or doubtful cases (the so-called "formes frustes"), in most of which the dangers of operation are little, if at all, greater than those of ordinary goitre. These, in the hands of practised surgeons, have been reduced to complications and accidents.

Taking into consideration only those cases in which the diagnosis can admit of no doubt, cases in which exophthalmos, tachycardia, tremor and goitre are all present, it will be found that the dangers of operative interference fall into two classes, which may be called (1) *The avoidable*, and (2) *The unavoidable.*

1. **Avoidable Dangers.**—These are due to difficulties inherent in the operation itself, and which can be overcome largely by experience, manipulative skill, and knowledge of their liability to occur. Thus in operations for exophthalmic goitre it can scarcely be doubted that there is greater liability to (*a*) hæmorrhage, and probably also to (*b*) sepsis.

a. The firmness and solidity of the organ in this disease, and the peculiar thinness and delicacy of the vessels, especially the veins, make the liability to hæmorrhage much greater than in operations for ordinary goitre.

It must not be forgotten that an amount of hæmorrhage, which would be of little or no importance in an operation for ordinary parenchymatous goitre, may easily lead to a fatal issue in the case of an exophthalmic goitre of corresponding size. Exophthalmic patients do not stand hæmorrhage at all well, and if the operation be a prolonged or difficult one, the total loss of blood may be

considerable. Veins are more liable to tear, bleeding vessels are more difficult to secure, and bleeding from the cut surface of the gland is more difficult to control, owing to the friability of the comparatively solid gland substance.

It is my own belief, founded both upon my own operations and upon those that I have seen performed by others, that death following upon them is often due to sheer loss of blood. This may not at the time seem excessive, but it is more than the exophthalmic goitre patient, enfeebled by acute or prolonged toxæmia, is able to withstand.

b. It seems to me, although I feel less strongly upon this point, that in exophthalmic goitre there is greater danger from sepsis than in ordinary goitre, probably for the reason mentioned above, that the patient is less able to destroy any germs that may have made their way into the operation wound. Presumably some germs get into all operation wounds, whatever care may be taken to exclude them. A smaller number seem to be able to set up septic symptoms, such as temporary elevation of temperature and rapid pulse, than is the case with ordinary goitre. The use of irritating and poisonous antiseptic lotions appears to me to be harmful in all goitre operations, and probably more so in exophthalmic than in others. Certainly, since I have wholly abandoned the use of such lotions in ordinary goitre operations, the wounds have healed with a smoothness and rapidity which was not so uniformly observed in earlier operations. It is possible, however, that increased rapidity in operating may have played some part in the improved results.

2. **Unavoidable Dangers.**—In the second class of case the danger lies in the condition of the patient, namely:—(*a*) In the acuteness of the thyroid intoxication; (*b*) In the presence of visceral degenerations, either set up by prolonged intoxication, or perhaps independent of the thyroid disease.

In all these cases it is in the condition of the heart more especially that the danger lies. We may consider each of these two classes separately.

a. Acuteness of intoxication.—If the patient is suffering from acute thyroid intoxication, as shown by great mental excitement, delirium, or mania, operation should never be performed. The most severe forms may be progressive, and the patient may die without the occurrence of any period during which operation could be performed with any reasonable chance of success.

But Graves's disease is one in which it is much more common to find periods of exacerbation alternating with periods of remission. The surgeon should be careful to avoid operating in a period of exacerbation, and be content to treat the patient with rest, *x*-rays, milk, sodium salts, and such other medical treatment as may seem advisable.

It is just in the period of exacerbation that the patient herself or her friends (and sometimes the family doctor) are apt to be most anxious for operative treatment. But the prudent surgeon will prefer to wait until the more favourable period of remission sets in.

A good deal may be done by judicious nursing to allay the mental excitement. It is, I believe, never wise to operate on an exophthalmic goitre patient immediately, or very soon, after admission to hospital or nursing home. Many days, in some cases even weeks, should elapse before the operation is undertaken. My ordinary practice is to allow at least a week before undertaking an operation.

During this period the Sister of the ward, or the private nurse, if experienced in this class of case, can do much to allay the very natural fear and much of the mental excitement of these patients. Often both temperature and pulse-rate and the general "jumpiness" subside considerably. In a hospital ward where there are usually several other cases of the same kind, either awaiting or having recently undergone operation, the patient has a distinct advantage. She sees and talks to others who have gone through the ordeal which she naturally dreads, and almost invariably derives much encouragement from them.

It is a common experience in my wards for a patient, who on admission is in a state of considerable excitement and nervous trepidation, to settle down so quickly that before many days have passed she is comparatively quiet, and eager for her operation to take place. Indeed the difficulty generally is to persuade her to wait a sufficient length of time. I never like to operate on a patient who is in a state of great fear, still less on one who is at all unwilling to submit to operation.

If the patient is suffering from any temporary acute infection, such as a common cold or bronchitis, operation should certainly be postponed until the complication has subsided.

b. Visceral degeneration.—The second class of dangerous cases is that in which serious visceral degeneration is present, generally the effect of long-continued toxæmia. By far the most important of these is dilatation of the heart. Charles Mayo says,[11] "Dilatation of the heart which exceeds one inch is a serious condition, while that of an inch and a half will give a percentage of unavoidable mortality for the radical operation of thyroidectomy."

The danger in these cases is that the patient may die quite suddenly, either during the operation or within a day or two afterwards. When we consider how common it is for a patient with bad exophthalmic goitre to die suddenly, quite independently of any operative proceeding, it is not surprising that a surgical operation, however slight and however skilfully performed, should sometimes precipitate such a disaster.

The amount of risk in this second class of case depends largely upon the degree of visceral degeneration that is present. The risk can easily be greatly increased if the operator is neither skilful nor careful.

THE QUESTION OF ANÆSTHESIA.

There is much difference of opinion as to the advisability of administering a general anæsthetic in operations for exophthalmic goitre. While some surgeons, such as Kocher and Dunhill, use local anæsthesia almost exclusively, others, and notably Charles Mayo, consider that ether may be given with safety in most cases, and reserve the use of local analgesia for a minority in which special danger is to be feared. My own opinion is that for most of the minor forms of the disease there is but little danger in the use of ether if properly administered by a skilled anæsthetist. But for the more acute cases, and for most others in which cardiac complications are to be feared, it is preferable to employ local analgesia, if the patient is willing to suffer the discomfort which is a necessary accompaniment of such a proceeding.

The chief advantages of local analgesia are that the patient is less likely to retch or vomit after the operation, and that large quantities of water can be

drunk immediately after, or even during, the operation. This latter is a very important method of preventing post-operative tachycardia.

The disadvantages are obvious, especially in the case of a nervous patient. If there be any truth in the theory that fright is one of the actual causes of the disease, it can scarcely be a good thing to subject a patient for half an hour or an hour, or perhaps even more, to the strain of undergoing an operation without general anæsthesia. The psychic effect upon a very nervous patient may be more injurious than that of a general anæsthetic. In such cases, a combination of the local and general methods may be used with advantage, novocain being injected locally, and either gas and oxygen, or ether in very small amount, being administered by inhalation. In this way a very satisfactory but extremely light anæsthesia may be maintained, consciousness being only just abolished, and returning rapidly when the anæsthetic is withheld.

I have myself entirely abandoned the use of chloroform for all goitre operations, believing that ether administered by the open method is better. The depth of anæsthesia is, in my opinion, important. The patient should never be deeply under the influence of the anæsthetic. The less poisoning the better for her.

During the middle stages of the operation, which are usually the least painful, the administration of the anæsthetic may often be almost wholly suspended.

If only light anæsthesia has been maintained, trouble from post-anæsthetic vomiting is very rare. Vomiting once or twice, immediately after the operation, is usually all that occurs, and in a large number of cases there is no vomiting at all. Crile's method of "stealing the gland," by administering an anæsthetic on several occasions before the real operation is undertaken, so that the patient does not know when it is to be performed, seems to me to have little in its favour, and I have never employed it.

The method of producing local analgesia which I have used exclusively for the last two years is that recommended by Mr. Dunhill, of Melbourne. The solution consists of:—

Novocain	.. .. ..	gr. vj.
Sodium chloride	.. ..	gr. xxij.
Distilled water	.. ..	200 c.c.

This maximum dose is never exceeded, even for resection, while for ligation of the thyroid arteries about 50 c.c. is sufficient.

The solution is prepared with sterile materials and is boiled just before use, and 20 min. of a 1–1000 solution of adrenalin hydrochloride is added to it previous to injection. This is carried out with a 20 c.c. syringe of powerful make, with fine long needles, so that only a limited number of punctures need be made.

Veins are of course carefully avoided, and I have had no trouble whatever from pricking of any important vessel. The injection is first made along the line of the proposed incision in the skin, but later on, the tissues far back in the neck and right up to the mastoid processes are carefully infiltrated.

It is usually necessary to wait about thirty minutes before the drugs have acted sufficiently to permit the skin incision to be made.

Injections into the muscles and around the upper pole of the gland should be made with great caution, and it is often better to carry out this stage after the skin flap has been raised.

RESULTS OF OPERATION.

Discussion of the results of operation centres round two points:—(1) *The actual mortality of the operation*; (2) *The extent to which the disease can be benefited or cured.*

1. **Mortality.**—This varies within very wide limits according to the experience and skill of the operator, the severity of the case, and the nature of the operation performed.

"The mortality," says Mr. Wilfred Trotter,[12] "presents this encouraging peculiarity, that it can be, and invariably is, reduced as the surgeon acquires experience in the special requirements of the operation."

The average mortality of operations for exophthalmic goitre in the large general hospitals of London has undoubtedly been very high. Among 97 operations for removal of exophthalmic goitre performed in the last few years in nine of these hospitals, there were 16 deaths. All, or nearly all, the cases appear to have been well-marked examples of the disease.

In yet another London hospital, of which the recent statistics have been communicated to the Royal Society of Medicine by Dr. Hector Mackenzie, there had been 6 deaths among 19 patients.

The high mortality in these ten hospitals is probably to be accounted for in two ways. In the first place, the London hospital physician as a rule does not call in a surgeon to a case of exophthalmic goitre until the disease is far advanced. In the second place, owing to the system that obtains in most London hospitals, the surgeon who is eventually called in by the physician is almost invariably the surgical colleague who "corresponds" to him on the staff of his hospital. This surgeon may or may not have acquired that "experience in the special requirements of the operation" of which Mr. Trotter wisely speaks.

It is worth noting, for example, that in the 97 cases mentioned above, chloroform was used as the anæsthetic in at least 55: in 10 only was local analgesia reported to have been employed.

If we turn to the mortality-statistics of individual surgeons of larger experience, we find a very different set of figures. The low mortality obtained at present by Kocher is too well known to need quotation again. Charles Mayo has had an unbroken series of 278 operations (ligations and removals) without a death.

Hildebrand, of Berlin,[13] speaking in December, 1912, of his experience of nearly 200 operations for Graves's disease, stated that in his last 95 operations (ligations and thyroidectomies) performed in 1911 and 1912, there had been 2 fatal cases. His previous operations had shown a mortality of 4 to 5 per cent.

My own statistics for the year 1913* comprise 24 cases of thyroidectomy,

---

* Statistics of all my operations for exophthalmic goitre up to the end of 1912 were published in my Lettsomian Lectures delivered before the Medical Society of London in February and March 1913, *Trans. Med. Soc.* 1913, and *Lancet*, 1913, March 1, 8, and 15.

besides about a dozen ligation operations; all were for typical well-marked cases of the disease; all had exophthalmos and the usual classical symptoms. There was one death among the thyroidectomies; this occurred in a man aged 50 with a severe form of the disease. There were no deaths after mere ligation. During the same year, 1913, the number of cases of removal of goitre other than undoubted exophthalmic amounted to 95. Among these there was one death; that of a patient with a recurrent thyroid tumour who also had marked glycosuria, and who died three weeks after operation. A good many of these 95 patients presented some of the symptoms of Graves's disease, especially tachycardia and nervous symptoms, and would have been classed by many surgeons among their " exophthalmic " goitre cases.

2. **Extent of Benefit or Cure.**—It must be admitted that immediate and complete cure but rarely results from operation in well-marked cases of the disease.

In the minor forms to which allusion has already been made, in which a few only of the symptoms are present and in which exophthalmos itself is absent, such immediate and complete cure is common enough, and it is not necessary to refer again to this class of case.

With regard to pronounced cases, about the correct diagnosis of which there is no doubt at all, the cure is certainly less rapid, and usually less complete. But what has made the most impression upon me in the last few years, during which I have been operating somewhat freely upon pronounced cases of Graves's disease, is the great amount of benefit that the patients have almost always received as the direct and speedy result of the operation.

Within a very few days the patient almost invariably volunteers the statement that she already feels very much better than she has felt for months or years. A feeling of well-being sets in; the sense of nervousness and depression which had made life burdensome and miserable rapidly disappears.

The next thing noticeable is that the pulse-rate drops gradually and steadily, often falling in a week or two from 120 or 130 to 80 or 90. It is still liable, however, to periods of exacerbation under the influence of excitement or emotion. But these periods of exacerbation become less frequent and less marked, and cause much less distress than before. Palpitation becomes much less frequent and often disappears altogether.

Almost uniformly there is considerable increase in the body-weight, amounting to 20 or 30 pounds in the course of a few months. The general nutrition of the body is obviously greatly improved.

The exophthalmos usually diminishes but slowly. This is the feature of the disease which is usually least affected by the operation. But it, too, may gradually disappear.

But even though some of the objective symptoms may persist to a greater or less extent—notably exophthalmos and perhaps some undue frequency of pulse—yet patients after operation usually become able to return to work and to live once more, to a large extent, happy and contented lives. " I feel a new woman " is an expression I have often heard from patients within a few months of an operation for exophthalmic goitre.

It may be said that a similar amount of benefit may follow medical treat-

ment, and undoubtedly this is sometimes the case. But benefit from medical treatment is usually very slow and irksome, and most uncertain. Those who can afford to lie up for one or more years may succeed in wearing out the disease, if in the meantime they have not died, or become the subject of incurable dilatation of the heart or some other visceral complication due to the long-continued toxæmia.

It is on account of this possibility of the spontaneous cure of the disease by medical treatment that I do not recommend operative treatment, with its manifest, even if comparatively slight, risks, to all patients in the earliest stages of the disease, as some surgeons are already inclined to do. But medical treatment, unless speedily followed by marked and steady improvement, should not be persevered with indefinitely. Probably in most cases a trial of medical treatment for two or three months is all that should be allowed, unless distinct and progressive benefit can be shown to follow. The establishment of a correct prognosis in the early stages of the disease is a very real difficulty.

It can certainly be said with truth that there is no drug yet known, nor any method of medical treatment, which produces such marked improvement in the symptoms of Graves's disease, or produces it so speedily, as does a well-planned and well-executed surgical operation.

There can be equally little doubt that those who will take the trouble to learn from the great Continental and American masters, who have already taught us so much about the selection of the proper cases for operation and of the details of the operations themselves and the after-treatment, will find that an immense

THYROIDECTOMIES FOR EXOPHTHALMIC GOITRE

Case No.	Date of Operation	Name	Age	Chief Symptoms	Duration of Symptoms	Operation
753	Jan. 15	Frances W.	33	Typical. Exophthalmos, palpitations, tremors, wasting. Heart 1 in. outside nipple; systolic bruit at apex	1 year	Extirpation left lobe and isthmus.
764	Feb. 24	Matilda P.	35	Typical. Exophthalmos, tachycardia, tremors, slightly dilated heart	2 years	Extirpation right lobe.
766	Feb. 26	Caroline W.	35	Typical. Exophthalmos, tachycardia, tremors, heart slightly dilated, systolic murmur at apex	1 year 8 months	Extirpation right lobe, after previous ligation of left sup. thyroid artery
782	May 5	Thomas M.	47	Typical, with extreme exophthalmos and emaciation, diarrhœa, tachycardia, tremors, heart dilated	1 year	Extirpation right lobe

amount of good can be done by surgery to those who are so unfortunate as to suffer from this most distressing and disabling disease. At the same time, the surgery of exophthalmic goitre is far from being as satisfactory as we could wish. The mortality after operation, although it has been enormously reduced, still stands at a much higher level than that of operations for ordinary goitre, and there is still much to be learned as to the stage of the disease at which operative interference can be practised to the best advantage. Although the main principles of the best methods of operating are fairly well established, there are yet many details of technique about which we would fain have clearer and more definite views.

REFERENCES.

1 JOFFRAY, *Progr. Méd.*, 1894, xix. 61, 165, 205, 217.
2 THORBECKE, *Inaug Diss.*, Heidelberg, 1905.
3 CAPELLE, *Münch. med. Woch.*, 1908, Sept. 1; *Beit. z. klin. Chir.*, 1911, lxxii, 214–238.
4 RENDU, *Dict. Dechambre*, art. "Goitre Exophtalmiques," 1893.
5 GEBELE, *Beitr. z. klin. Chir.*, 1910, xx, 20–26.
6 ZESAS, *Deut. Zeitschr. f. Chir.*, 1910, cv, 125–152.
7 GARRÉ, *Wein. klin. Woch*, 1911, xxiv, 616.
8 VON HABERER, *Deutsch med. Woch.*, 1913, xxxix, 773.
9 MELCHIOR, *Centralbl. f. d. Grenzgebiete der Med. und Chir.*, 1912, xv.
10 LENORMANT, *Jour. de Chir.*, 1909, ii, 601–621; *Ibid.*, 1912, Sept., 273–285.
11 "Factors of Safety in Operating for Exophthalmic Goitre." Collected papers, Mayo Clinic, 1912, 511.
12 *Proc. Roy. Soc. Med.*, 1912, v, pt. iii, surg. sect. 98.
13 *Verhandl. d. Berlin. mediz. Gesellschaft*, 1913, xliii, 299.

PERFORMED BY THE AUTHOR DURING THE YEAR 1913.

NATURE OF GOITRE	RESULT * Recovered	REMARKS	ANÆSTHETIC	LATEST REPORT
Typical solid exophthalmic goitre. No visible colloid. Weight 8 oz.	* R.	Drainage 1 day. Primary union	Ether	April, 1913. Very much improved (personal observation). March 24, 1914, "Palpitation very much better, have been working some months" (letter)
Typical solid exophthalmic goitre. Weight 1 oz	* R.	Drainage 1 day. Primary union	Local, novocain and adrenalin	March, 1914. Improved (letter)
Typical solid exophthalmic goitre, no visible colloid. Weight 2 oz.	* R.	Drainage 1 day. Primary union	Local, novocain and adrenalin	Aug., 1913. Very much improved (pers. obs.)
Typical solid exophthalmic goitre, with scarcely any colloid	* R.	Drainage 1 day. Primary union	Local, novocain and adrenalin	Improved very much in first few months and put on much weight. Dec., 1913, readmitted for a few days with relapse. No further operation, discharged to a convalescent home; since then has put on 24 lb. in weight, and is much better (letter)

[*Continued on next page.*

THYROIDECTOMIES FOR EXOPHTHALMIC GOITRE PERFORMED BY

Case No.	Date of Operation	Name	Age	Nature of Symptoms	Duration of Symptoms	Operation
783	May 5	Florence Y.	16	Typical. Exophthalmos, tremors, tachycardia, dilatation of heart	7 months	Extirpation right lobe
784	May 6	Mrs. W.	29	Typical. Exophthalmos, tachycardia, tremors, etc.	Over 4 years	Extirpation right lobe
787	May 19	Mrs. W.	28	Typical, with emaciation and bronzing, tachycardia, moderate exophthalmos	15 months	Extirpation right lobe, after previous ligation of sup. thyroid artery
789	May 20	Ada McC.	31	Typical, with bronzing. Exophthalmos, tremors, tachycardia, diarrhœa, emaciation	4 years	Extirpation right lobe
791	May 21	Florence U.	29	Typical. Exophthalmos, tremors, palpitation, wasting, dyspnœa	8 months	Extirpation right lobe
798	June 4	Ada L.	40	Typical, but mild. Exophthalmos definite, tachycardia, tremors, no cardiac dilatation	6 months	Extirpation right lobe
799	June 9	Daisy W. R.	24	Typical, moderately severe type. Exophthalmos, nervousness, palpitation, heart slightly dilated	5 months	Extirpation right lobe
800	June 9	Edith W.	24	Typical, but mild. Exophthalmos, slight tremor, slight tachycardia, diarrhœa	12 months	Extirpation right lobe
812	June 24	Percy F.	30	Typical. Exophthalmos, emaciation, tachycardia, tremors, much excitability, heart much dilated, 1½ in. outside nipple	2½ years	Extirpation right lobe after previous ligations of both sup. thyroid arteries
815	July 1	Miss B.	23	Typical. Exophthalmos, tremors, nervous depression, etc.	7 months	Extirpation right lobe
817	July 7	Clara F.	39	Typical. Exophthalmos, tremors, tachycardia, heart slightly dilated, systolic murmur	9 months	Extirpation right lobe after previous ligation of superior thyroid artery

BY THE AUTHOR DURING THE YEAR, 1913—*continued.*

Nature of Goitre	Result * Recovered	Remarks	Anæsthetic	Latest Report
Typical solid exophthalmic goitre, a little colloid	* R.	Drainage 1 day. Primary union	Ether	Much improved when last seen 3 months later. March 20, 1914, "I am glad to tell you I am feeling much better; my eyes are decidedly much better, still slight palpitation, nerves better, and I have been able to work since Xmas" (letter)
Typical solid exophthalmic goitre. Weight 1 oz.	* R.	Drainage 1 day. Primary union	Ether	Aug., 1913. Has put on much weight, exophthalmos almost gone; looks and feels very well. Counts herself quite well (letter) Oct., 1913. "Still very well, gone abroad" (letter)
Typical solid exophthalmic goitre. Weight about 1½ oz.	* R.	Drainage 1 day. Superficial skin infection, wound healed in 17 days	Ether	Somewhat improved when last seen some months later, but still far from well
Typical solid exophthalmic goitre	* R.	Drainage 1 day. Primary union	Local, novocain and adrenalin	Great improvement (exophthalmos much less, pulse quieter, feels very much better), but in March, 1914, had a slight relapse, for which ligation of sup. thyroid artery performed March 16, 1914; no reaction afterwards
Typical solid exophthalmic goitre	* R.	Drainage 1 day. Primary union	Local, novocain and adrenalin	Nov., 1913. Very well indeed, and at work as a nurse (pers. obs.)
Typical solid exophthalmic goitre, with scarcely any colloid. Weight 1 oz.	* R.	Drainage 1 day. Primary union	Ether	July, 1913. Quite well (letter). Mar. 20, 1914, exophthalmos quite gone, no tachycardia, pulse 70. Not nervous, able to work, heart reported to be absolutely normal (pers. obs.)
Typical solid exophthalmic goitre	* R.	Drainage 1 day. Primary union	Local, novocain and adrenalin	July 14, 1913. Scarcely any symptoms remained; says she feels "very well." Since then has put on 2 stone in weight (pers. obs.)
Typical solid exophthalmic goitre. Weight 1 oz.	* R.	Drainage 1 day. Primary union	Ether	Oct., 1913. Much better, very little exophthalmos. Feb., 1914, as before (pers. obs.)
Typical solid exophthalmic goitre, no visible colloid. Weight about 1½ oz.	* R.	Drainage 1 day. Primary union	Local, novocain and adrenalin	Dec., 1913. Looks and feels very well, exophthalmos almost gone, has put on much weight. Very little tremor, still a good deal of nervous excitement, about to return to work (literary)
Typical solid exophthalmic goitre, no visible colloid	* R.	Drainage 1 day. Primary union	Local, novocain and adrenalin	March 23, 1914. Practically quite well, looks and feels very well. Pulse 92. Has put on much flesh, exophthalmos almost entirely disappeared (pers. obs.)
Typical solid exophthalmic goitre, no visible colloid	* R.	Drainage 1 day. Primary union	Ether	Feb., 1914. Marked improvement in all respects, and at work as a nurse (pers. obs.)

[*Continued on next page.*

THYROIDECTOMIES FOR EXOPHTHALMIC GOITRE PERFORMED BY

Case No.	Date of Operation	Name	Age	Chief Symptoms	Duration of Symptoms	Operation
829	July 28	Mary S.	43	Typical, with moderate exophthalmos, and some dyspnœa, slight dilatation of heart	6 months	Extirpation right and middle lobes
831	July 29	Miss R.	30	Typical, with marked exophthalmos and much nervous depression	Nearly 3 years	Extirpation right lobe
843	Oct. 20	James S.	50	Exophthalmos slight, much emaciation and bronzing, tremors, tachycardia, old goitre of 30 years' duration	6 months	Extirpation right and middle lobes
844	Oct. 21	Miss W.	25	Typical. Exophthalmos slight, tachycardia, dyspnœa, nervousness	About 4 years	Extirpation right lobe
847	Oct. 23	Miss E. B.	40	Typical, but mild. Exophthalmos, tremors, tachycardia, wasting, pulse slightly irregular	About 1 year	Extirpation right lobe
848	Oct. 27	May R.	21	Typical. Exophthalmos, tachycardia, tremors, heart slightly dilated	10 months	Extirpation right lobe
851	Nov. 3	Evangeline H.	20	Typical. Exophthalmos, tachycardia and dyspnœa, tremors, heart moderately dilated	5 years	Extirpation right and part of left lobes
856	Nov. 13	Mrs. B.	43	Typical. Exophthalmos, tachycardia, tremors, severe diarrhœa, slight dilatation of heart	4 years	Extirpation right lobe
867	Dec. 3	Edith U.	25	Typical. Exophthalmos, tremors, tachycardia, wasting, bronzing, heart slightly dilated	2 years	Extirpation right lobe

Besides the above series, there were several cases in which ligation only of one or both superior

BY THE AUTHOR DURING THE YEAR 1913—*continued.*

Nature of Goitre	Result * Recovered † Died	Remarks	Anæsthetic	Latest Report
Typical solid exophthalmic goitre. Weight 4 oz.	* R.	Drainage 1 day. Primary union	Ether	No news since leaving hospital
Typical solid exophthalmic goitre. Weight 1½ oz.	* R.	Drainage 1 day. Primary union	Local, novocain and adrenalin	Soon became almost well except as regards exophthalmos. March, 1914, had a slight relapse, for which left superior thyroid artery was tied (pers. obs.)
Atypical exophthalmic goitre with a good deal of colloid. Weight 9¼ oz.	† D.	Operation well borne but recurrent hæmorrhage from a small unnamed vein led to death from cardiac failure 3 hours after operation, no post-mortem	Local, novocain and adrenalin with one drm. of ether by inhalation	
Typical solid exophthalmic goitre	* R.	Drainage 1 day. Primary union	Ether	Jan., 1914. Looks and feels very well, exophthalmos less (pers. obs.)
Typical solid exophthalmic goitre. Weight 1 oz.	* R.	Drainage 1 day. Primary union	Ether	Feb., 1914. Very well, and at work as a children's nurse. Has regained her normal weight. Exophthalmos no longer visible. Pulse generally about 70 (pers. obs.)
Typical solid exophthalmic goitre	* R.	Drainage 1 day. Primary union	Local, novocain and adrenalin	March 20, 1914. "Eyes are quite normal. I am in no way nervous. I have been at work since before Xmas, and feel much better in myself than for 2 years. I do not require any medical treatment" (letter)
Goitre with a good deal of colloid, focal areas of Graves's disease. Weight 1½ oz.	* R.	Drainage 1 day. Primary union	Ether	March 25, 1914. "I am feeling much better, my eyes are less prominent, am still nervous, but am able to work, palpitation is better" (letter)
Typical solid exophthalmic goitre, size of small hen's egg, still contained a little colloid	* R.	Drainage 1 day. Primary union	Ether	Dec. 14, 1913. "I have been gaining strength daily, and my heart is certainly better already" (letter). No later note.
Typical solid exophthalmic goitre, no colloid	* R.	Drainage 1 day. Primary union	Local, novocain and adrenalin	Feb. 1914. Much better in all respects, and has put on 26 lb. in weight (pers. obs.)

arteries was done. There was no mortality, and all are improved, some very markedly.

INSTRUCTIVE MISTAKES.

CASE 17.

A CASE OF FRONTAL MUCOCELE MISTAKEN FOR A SARCOMA.

THE patient was a widow, aged 69. For three years past she had suffered from severe frontal headache, and for the latter part of this period a hard swelling had made its appearance over the inner angle of the left eye. About one year before the photograph was taken, the swelling was quite hard and evidently growing from the bony wall of the orbit. It was diagnosed as a sarcoma, after consultation with several surgeons and eye specialists. The patient being quite dependent upon her relatives, the latter bought an annuity for her on special terms, after submitting a medical certificate to the insurance company to the effect that she was suffering from an inoperable malignant disease which would probably end her life within two years. However, in less than a year from this date it became apparent that an error had been made. The swelling rapidly increased, pushing the left eyeball downwards and outwards, and almost destroying the vision on that side (*Fig.* 476). Very distinct egg-shell crackling could be obtained over the surface of the tumour, and this made it clear that it was of a cystic nature. Operation was undertaken in January, 1907. The tumour consisted of a huge mucocele which occupied both frontal sinuses, and which, by its pressure, had caused great atrophy of the frontal bone, both externally and towards the brain. The contents were thick brown mucoid material. All the front wall of the cyst was removed, and the patient made a good recovery. The left eye soon regained its natural position, and vision was so far restored in it that

FIG. 476.—FRONTAL MUCOCELE OF THREE YEARS' STANDING, CAUSING DISLOCATION OF THE EYEBALL.

she could see the time on the clock, the other side of a large ward, before she left the hospital.

Her unexpected recovery led to serious trouble between the relatives who had bought her annuity and the company who had undertaken to pay it; but eventually, it is believed, she continued to receive her money, and she is still living in an almshouse.

Case 18.

A CASE OF ACUTE APPENDICITIS MISTAKEN FOR ONE OF STRANGULATED HERNIA.

M. C., a very stout widow lady, aged 73, was taken ill on Jan. 15, 1914, with abdominal pain and vomiting. She was seen by two medical men, who made a diagnosis of strangulated hernia, and she was at once transferred to a nursing home.

She was very deaf and somewhat agitated, and therefore no very accurate history could be obtained from her. Apparently she had never had any severe illness of any kind, but said that some years ago she had an attack similar to the present, which lasted for about one week and then was relieved by aperients. The present attack began with vomiting, which had recurred at intervals for the past two days, and during all this time she had passed neither motion nor flatus.

The abdomen was much distended, but owing to her corpulence very difficult to examine. There was a small umbilical hernia, quite irreducible, but not specially tense or tender. There was no marked pain or tenderness anywhere in the abdomen at the time of examination.

The pulse was 96, temperature 99°, and her general condition very good. There seemed no reasonable doubt about the diagnosis of strangulated umbilical hernia, as there were present a hernia which was irreducible, absolute constipation, persistent vomiting, and abdominal distention. The only point which arrested attention was the absence of local tenderness or any feeling of tension over the small hernial sac. This was attributed to the patient's obesity.

An incision was made over the sac, and on opening the latter a small mass of adherent omentum and a knuckle of small intestine were exposed. But there was no evidence of strangulation in the appearance of the bowel or in the portion which passed through the neck of the sac. The opening was therefore enlarged, with the idea that a kinked piece of bowel might have been reduced *en masse*. After pulling out a few coils of intestine, flakes of lymph were found, pointing to peritonitis. The incision was further enlarged downwards and the cæcum examined. The appendix was terminal, very small and short. It was perforated by a minute aperture near its base, and through the perforation purulent material was escaping. An early plastic peritonitis with lymph deposits was present all round the ileo-cæcal area. The appendix was removed, the abdomen drained through a separate iliac stab wound, and the median incision closed completely.

The patient made a good recovery, but the median incision suppurated, as might have been anticipated after contamination with the septic appendix area.

The mistake here detailed was almost inevitable. The very marked constipation was probably accentuated by the presence of a coil of ileum in the

hernia. The gravity of the mistake consists in two facts; first, that the appendix disease might have been overlooked altogether; and second, that the exploration of the septic focus in the iliac fossa through the median wound, with all the intestines exposed, involved a great risk of diffuse peritonitis. It would probably have been safer, and certainly quicker, to have drained the lower end of the main wound, instead of trusting to the stab incision.

It would be very interesting to know whether the mistake of overlooking acute appendicitis in conjunction with irreducible femoral and inguinal hernias has ever been made, and if so, with what results.

Case 19.

ACUTE APPENDICITIS MISTAKEN FOR TRAUMATIC CONTUSION.

About ten years ago, when I was casualty officer at a large hospital, a lad, aged 18, walked in, complaining that he was suffering from the effects of a blow on the abdomen received from a football the evening before. This had not been sufficient to knock him down, and although still feeling some pain, he had walked home and slept well. As the abdomen was still painful and tender he came up for advice, about twenty hours after the accident.

On examination, the boy did not look ill, the pain was not very severe, he had not vomited, and the pulse was normal. The temperature was not taken (as it proved, this was a fatal oversight). On exposing the abdomen, it was found that there was tenderness and some rigidity in the right lower part, where he had been struck. Nothing else could be found abnormal; there was no free fluid; there had been no hæmaturia. It was considered that as he was so well, some twenty hours after the injury, there could not possibly be a rupture of any abdominal viscus, and he was told to go home and rest for a day or two.

On the next day but one the patient was sent into hospital by a doctor, suffering from acute general peritonitis. The abdomen was opened, and an acutely inflamed appendix was found to have perforated. He died next day.

A few months ago, in the out-patient department, a boy was brought to me complaining of pain in the abdomen following a prod with an umbrella on the day previous. There appeared to be very little the matter except slight tenderness, but as the blow was in the right iliac fossa, I related to the student present the above tragical story, and, as a precaution, took the temperature. This was 100°. The boy was admitted, and an early inflamed appendix removed by operation.

SHORT NOTES OF RARE OR OBSCURE CASES.

INTUSSUSCEPTION OF THE VERMIFORM APPENDIX, THE INTUSSUSCEPTUM PROTRUDING FROM THE ANUS.

By F. F. BURGHARD, London.

Mr. Sinclair's interesting case of intussusception of the vermiform appendix, described by Messrs. McConnell and Wilson on page 673, recalls to my mind a case that I saw a good many years ago, which may be regarded not only as a rare one, but also as an instructive mistake.

Somewhere about the year 1890, I was asked to see a patient of Dr. Owen Coleman's in the Surbiton Cottage Hospital on account of rectal tenesmus accompanied by the passage of blood. The patient, who was a feeble subject of about 60, with bad chronic bronchitis and emphysema, said that his symptoms—which consisted of slight griping pains followed by rectal tenesmus and the frequent passage of blood and mucus—had been coming on for more than a fortnight and were steadily getting worse: he did not appear to have had any acute attack at any time. For two days previous to my seeing him he had been greatly troubled by the "back-passage coming down," which had led to considerable increase in the tenesmus and the bleeding.

On examination, there was seen a protrusion of the bowel from the anal orifice about the size of the closed fist. The mucous membrane was very deeply congested and had small bleeding areas scattered over it. Projecting from near the centre of the protruded mass was a purplish black swelling rather bigger than the top joint of the thumb, the apex of which was raw and bleeding freely, while the base had a papillomatous appearance.

The tumour was taken to be a polypus, causing prolapse of the rectal wall by its traction; a stout ligature was forthwith applied around its base and the portion beyond it cut away. I then did what I ought to have done at first, namely, examined the protruded mucous membrane with a view to replacing it; then I found to my consternation that it was obviously an intussusception and not a prolapse. An examination of the tumour removed then showed that it was the appendix vermiformis turned completely inside out. The purplish summit consisted of the much engorged lymphoid tissue normally found in the tip of the process, and the papillomatous portion near the base was a small papillomatous tumour springing from the mucous membrane either just at, or just distal to, the junction of the process with the cæcum. The orifice of the ileo-cæcal valve could be felt in the near vicinity of the ligatured appendix.

The patient was given an anæsthetic, and the abdomen was opened to the right of the median line below the umbilicus. After much difficulty the bulk of the intussusception was reduced, but the commencement was so fixed by firm adhesions that it could not be got out. Being in a great hurry to finish the operation, as the man's condition was getting bad, I made use of Mr. A. E. Barker's method—then recently introduced—and cut away the intussusceptum.

The patient died about the tenth day from purulent bronchitis, and no post-mortem examination was made. As far as could be judged, the bowel condition was satisfactory; good evacuations were obtained and there were no signs of peritonitis. Some blood was passed with the stools almost up to the day of his death. Presumably the traction of the growth had caused prolapse of the mucous membrane of the appendix into the cæcum, and this was followed by complete invagination of the vermiform process.

RECURRENT INTUSSUSCEPTION—"APPENDIX TUMOUR."

By STEWART ROUQUETTE, LONDON.

The following case is presented, not as a surgical success, but as a pathological curiosity, and claims attention solely on account of the rarity of the condition which it illustrates.

A boy, aged 4 years and 10 months, had been operated upon twelve days previously for ileo-cæcal intussusception. At that time there had been severe abdominal pain for twenty-four hours, blood and mucus had passed per rectum, and a mass had been felt in the right half of the abdomen. The intussusception had been reduced by operation, the appendix removed, and the stump buried by two purse-string sutures of No. 1 silk. The boy had remained well until the ninth day, when he vomited once; he continued to vomit at intervals during the next two days, and nothing was passed per rectum. On the morning of the twelfth day, when the patient was first seen, the bowels acted and a trace of blood was present in the motion; the bowels shortly afterwards acted twice, blood being found each time. On examination, the boy lay quietly in bed excepting when attacked by a spasm of pain, during which the abdomen became rigid and the expression anxious. In the epigastric region there could be felt an elongated, transversely-disposed mass which hardened at intervals and became more easily palpable. The liver edge could not be felt, but the nature of the tumour was perfectly evident; the apex could not be felt per rectum. The abdomen was quite flaccid, and deep palpation revealed the presence of several hard nodules, particularly in the right iliac region—these were thought to be enlarged glands.

The abdomen was opened through the old incision, i.e., through the right rectus muscle at the level of the umbilicus. The apex of the intussusception was felt at the splenic flexure, but the sensation experienced was so unusual that the presence of a "leading polyp" was suspected, a theory which accorded well with the rapid recurrence of the intussusception after the first operation. By intra-abdominal manipulation the apex was reduced along the transverse colon as far as the hepatic flexure; but here its progress was arrested, and in view of the friable nature of the bowel, the mass was delivered and reduction continued outside the

abdomen, every effort being made to guard against and minimize the effects of accidental rupture. Reduction was almost complete when the cæcal wall gave way and a polypoid tumour started through the rent. Clamps were immediately applied to the ileum and to the ascending colon, and the mass was resected, including about three inches of colon and two inches of ileum. As the conditions were favourable for axial anastomosis, that method of suture was adopted, though it necessitated slight puckering of the colic mouth. Some difficulty was experienced in the suture of the mesentery, owing to the presence of numerous large lymphatic glands which protruded obstinately from the cut surfaces and were with difficulty restrained within their own domain. The abdomen was closed in layers. After the operation, the patient showed remarkably little shock—he passed a good night, and on the following morning appeared to be in good condition; his recovery was uneventful.

FIG. 477.—DRAWING OF THE "APPENDIX TUMOUR" (natural size.)

The specimen showed acute congestion and great œdema of the cæcal wall, though actual gangrene had not yet commenced. From the lowest part of the cæcum there sprang a polypoid tumour, almost pedunculated, covered with granular mucous membrane, and measuring three-quarters of an inch in diameter. The appendix was wanting, but on the peritoneal surface of the cæcum a puckered dimple was found indicating the site of its amputation—this dimple exactly corresponded to the base of the tumour. On section, the polyp proved to be a much swollen and inflamed appendix stump, and in its midst two silk ligatures were found embedded.

Unfortunately, the drawing of the specimen was not prepared till several months after the operation, when considerable shrinkage of the tissues had taken place. The tumour was still further reduced in size by the excision of a sector for microscopy, so that it now presents a conical appearance, whereas in the fresh state it was spherical.

It was through the courtesy of Mr. Percy Sargent that I was enabled to deal with the case, and it is by his permission that I now publish the notes.

ANEURYSMS.

By J. RUTHERFORD MORISON, Newcastle-upon-Tyne.

In the whole of surgery I know of no more uncertain disease than aneurysm. Occasionally the most trivial help will cure it. At other times it has all the malignancy of the most malignant tumours.

TRAUMATIC ANEURYSMS OF THE RADIAL AND POPLITEAL ARTERIES.

Radial (Excision).—I have had some experience of traumatic aneurysms in the hand and its neighbourhood, and this (*Fig.* 478) I regard as a typical specimen. It is common to have a small foreign body such as a piece of steel sticking into the side of the artery, as in this instance. The aneurysm has been excised.

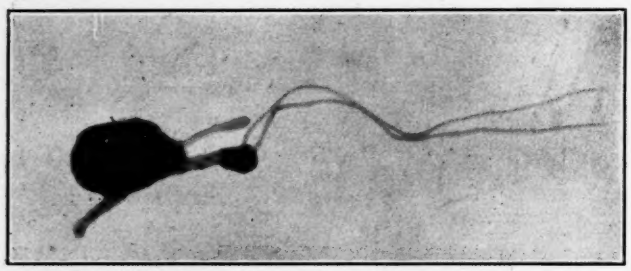


Fig. 478.—Traumatic Aneurysm of Radial Artery, with portion of embedded metal.

Popliteal (Matas' Operation).— Another variety of traumatic aneurysm has come under my notice, and I shall perhaps best convey what I know of it by relating a case.

The patient, a labourer, aged 65, was recently admitted to the Infirmary. Twelve years ago he strained his leg seriously in a cycle fall. A sudden sharp pain was felt on the inside of his right knee, and a lump developed. At first it was the size of a walnut. It caused little trouble until six months ago. Since then the leg has been painful, but not sufficiently so to lay him up. Suddenly, four days ago, the leg and foot became numb, painful, and cold.

He had an aneurysm about the size of a cocoanut in the popliteal space, with the typical expansile pulsation, varying much in its vigour from day to day. No pulsation could be felt in the vessels below the aneurysm.

At the junction of the upper and middle third of the right leg there was a regular dark line, and below this the skin was dusky, livid, cold, and insensitive. The superficial veins were enlarged. Pressure on the leg showed that there was still some circulation in it, but very little. The limb was rubbed with turpentine and then with spirit, then dusted with boracic acid. Boracic lint was put between the toes, the leg was wrapped up in cotton-wool, and the limb elevated

Patches of gangrene developed on the outer aspect of the leg about the middle, on the heel, and on the first, second, and third toes.

Operation.—April 12, 1913. Matas' obliterative operation was done, silk being used for the entrance and exit of the artery into the fusiform sac. The cavity of the sac itself was obliterated by a series of layers of continuous catgut suture. The operation had no ill effect on the gangrene.

On May 7, 1913, the first, second, and third toes were amputated. A gangrenous patch about the size of a five-shilling piece was excised from the heel, and a Wolff's graft sutured in its place. Nothing was done to the gangrenous patch on the outer side of the leg, from which a slough had separated. The wound on the toes and the grafted heel united by first intention, and the patient was sent home a month later, well, except for an ulcer about the size of a half-crown on the outer side of his leg.

It would have been impossible by any other operation to obtain such a result in this case. Excision of the sac would have involved removal of the popliteal vein which was adherent to it, and a great disturbance of the surrounding parts, because the sac was of such large size.

The sac was found to be partly filled with fluid blood, with a large round ball of loose clot in it.

The patient was neglected after going home, and he developed a septic cellulitis from infection through the ulcer. He was admitted ill on August 22, rather more than four months after the Matas' operation, and amputation through the knee was performed on August 23.

Dissection of the aneurysm showed that the sac had been entirely obliterated. The silk sutures could still be seen at either end of the sac. All signs of any catgut had disappeared. The popliteal artery and its proximal end were healthy and patent down to the sac. At its distal end it was filled with clot.

LEAKING ANEURYSM OF THE SUBCLAVIAN ARTERY—LIGATURE OF INNOMINATE AND RIGHT CAROTID ARTERY.

The patient, a male, aged 51, was transferred from Dr. Drummond's ward to me in January, 1912, with an aneurysm of the subclavian artery, which was leaking and rapidly increasing in size. A pulsating swelling occupied the lower part of the right side of the neck (*Fig.* 479). It extended nearly as far as the middle line, over the shoulder on to the deltoid, below the clavicle to about the level of the 3rd rib, and behind round the scapula. Pulsation, a thrill, and a systolic murmur were present all over the swelling. There was excruciating pain, with numbness and loss of sensation down the right arm, which was swollen and had enlarged veins.

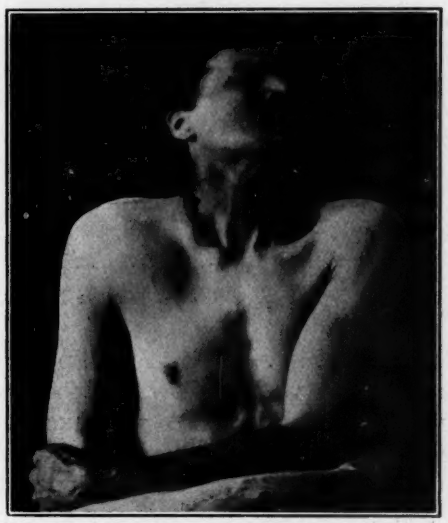


FIG. 479.—ANEURYSM OF SUBCLAVIAN ARTERY. Before operation.

I proposed to Dr. Drummond that I should put a temporary ligature round the innominate artery as the first step, then cut down upon the clavicle and turn out the extravasated blood, and if possible treat the aneurysm by Matas' method. I commenced the operation with that intention.

Operation.—July 20, 1912. An incision was made along the anterior edge of the right sternomastoid to the sternoclavicular joint, and then outwards along the clavicle (*Fig.* 480). The skin flap was turned back, and the sternal and a portion of the clavicular attachment of the sternomastoid were divided. It was then found that the aneurysm probably involved the second and third parts of the subclavian artery. The innominate was easily exposed and separated posteriorly, internally, and anteriorly, but on the outer side it was adherent, and had to be dissected off the surrounding tissue. A patch of disease in the vessel wall was seen to be the cause of this. In course of the separation a hole was accidentally made in the vessel. Mr. Angus, who was helping, skilfully

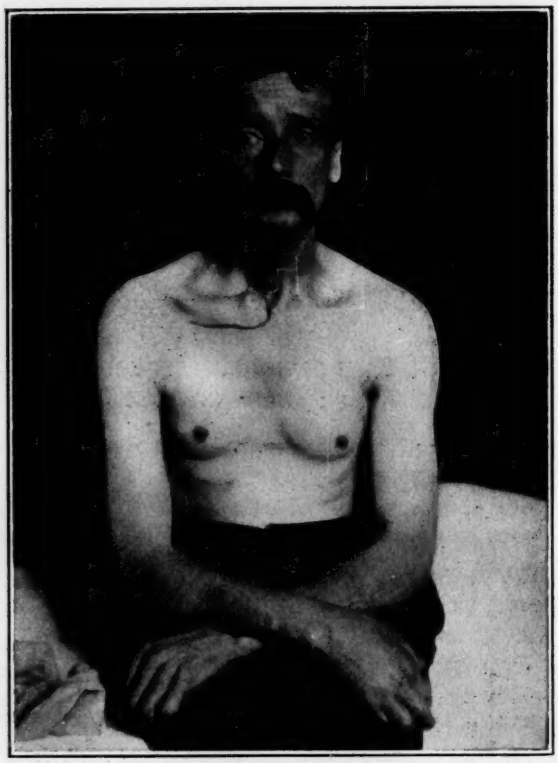


FIG. 480.—The same Patient after Operation. Note the incision.

occluded this with a pair of clip forceps, and I then passed a thick silk ligature round the vessel below the forceps. After consultation with my colleague, who gave me invaluable assistance, I decided to give up the original programme, and I occluded the innominate artery with thick soft silk ligatures tied quite tightly above and below the opening. I then tied the right common carotid with thick catgut. After applying the ligatures I covered up the wound, took a piece of fascia lata from the man's right thigh, and wrapped this round the ligatured vessels. The incision was closed without any drain.

After recovering consciousness, the agonizing pain from which he had previously suffered was gone. Instead of this there was complete anæsthesia

and paralysis of the arm. This continued to be complete for a fortnight, then some feeling began to return. The wound healed by first intention, and remained healed for six weeks. Then a small bleb formed at its lower extremity, and this continued to leak a little serous discharge for two months, when it permanently closed.

The patient is now living at Hull, and Mr. Upcott has been kind enough to interest himself in him on my behalf. He tells me that the condition of the arm is improving, and that the man is in good condition.

I felt no right to expect that this man would be cured by so unpromising an operation, but as I have suggested, the happenings in aneurysm are often the unexpected.

PLASTIC OPERATION ON THE HAND OF A YOUNG BOY.

BY J. RUTHERFORD MORISON, NEWCASTLE-UPON-TYNE.

A boy, aged 4, at the age of 2 had his hand caught in a reaping-machine This had torn the skin off the whole hand and had amputated the phalanges of the digits and thumb close to the metacarpo-phalangeal articulation. At the time

FIG. 481.—Shows flap from chest. Contraction has drawn the chest scar on to the abdomen.

I first saw him the stump of his hand was covered with granulation tissue, and there was no skin below the wrist. At first sight amputation of the hand appeared to be the only resource; but remembering the trouble I had had with

previous amputations in young people, knowing that the production of a conical stump would necessitate re-amputation more than once before he reached adult life, and recognizing that if the hand could be covered with skin it might still make a useful appendage, I determined to do a plastic operation.

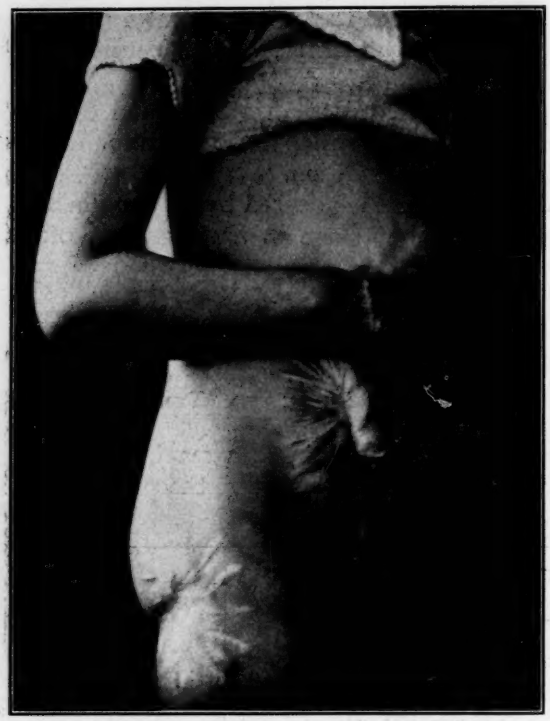


FIG. 482.—Note scars on abdomen and buttock.

I first made a pocket like the side pocket in trousers on the anterior abdominal wall, and placed the entire hand in this, sewing the skin of the abdominal wall to the skin of the wrist. To prevent adhesions of the hand to the abdominal wall, boracic lint was introduced between the two.

The first shock I got was to find what a large amount of separation of the abdominal skin I had to make in order to get the hand comfortably under it.

A fortnight later, I cut along the upper part of the pocket and turned a flap on to the palm, leaving the hand still attached to the lower part of the flap. The upper flap sloughed almost entirely. I then waited a month and cut along the lower edge of the pocket and turned this flap on to the palm. To my horror this also sloughed, so that only the back of the hand was covered, and fully half of the abdominal wall was bare. The condition then looked almost desperate.

The next thing I did was to make a flap from the buttock and cover the palm of the hand with this. This step, which ought to have been the first, was an immediate success, and the hand was now entirely and satisfac torily covered with skin. In order to help the bare area on the abdominal wall to contract, a large flap was turned down from the chest. The ultimate result was beyond my expectations (*Fig.* 481).

FIG. 483.—Condition of the hand as shown by a skiagram, May, 1913.

The hand is like a boxing glove; there is some movement of the phalanges and the hypothenar and thenar eminences under the skin, and the *x*-rays (*Fig.* 483) give the impression that further growth of the hand may make it

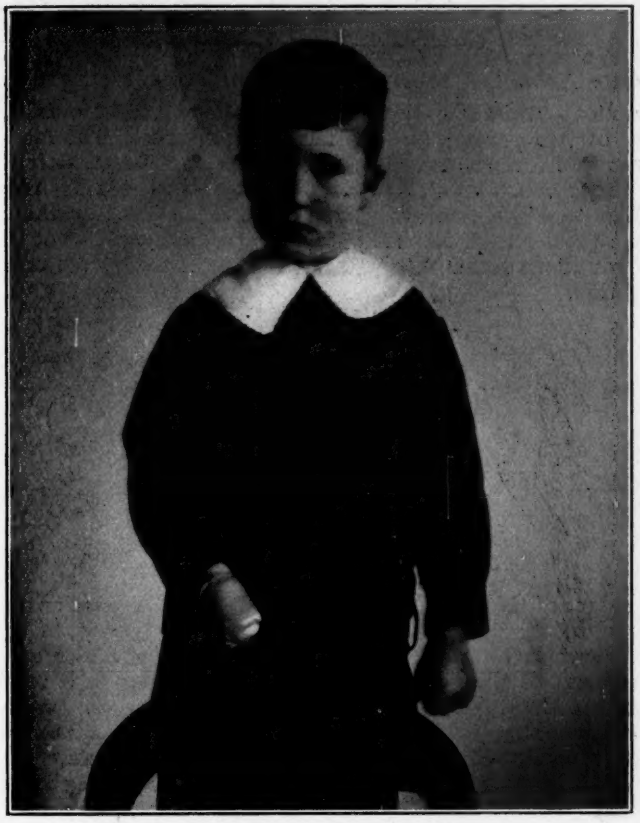


FIG. 484.—The patient at the age of 4½ years.

even more useful, as the muscles were not destroyed. By strongly flexing the hand stump and the forearm, he can hold gross articles, and he uses the stump for wiping his face, doing small jobs such as this quite naturally.

NEW INSTRUMENTS AND APPLIANCES.

A Semi-Automatic Abdominal Retractor. By JOHN EVERIDGE, London.

This instrument, a modification of the well-known Edmunds's Retractor, consists essentially of two parts : (1) The main portion, i.e., a handle with hoop and blade, which retracts towards the surgeon ; (2) A detachable shaft with a different-sized blade at either end. When one blade is used for retracting, the other serves as an adjusting handle. The two are united by a screw-joint at the shoulder of the main portion. In order to prevent slipping, the contact surfaces of the two parts are serrated, one turn of the screw being sufficient to lock the retractor at any required degree of retraction.

FIG. 485.

The advantages of this instrument are : First, it can be used as an easily-adjusted automatic retractor, any slip being quite impossible. Second, if the anæsthesia is not giving sufficient stability of abdominal muscles, the assistant can steady the instrument by means of the handle. He can also manipulate it to give exposure to any region of the operation field, as required by the surgeon, on either side of the incision. This frequently eliminates the necessity for two or more assistants being called upon to retract. Third, the lipping on the retracting blades allows the abdominal walls to be well held up for the purpose of reducing intestines. Messrs. Allen & Hanburys, of Wigmore Street, are making this instrument for me.

An Intra-uterine Douche. By R. DOUGLAS LAURIE.

The accompanying diagram represents a douche which I have found very satisfactory in maternity work.

The large size of the channels permits of a copious flow of lotion and an easy, unobstructed return. I have frequently given a couple of gallons of lotion in a few minutes.

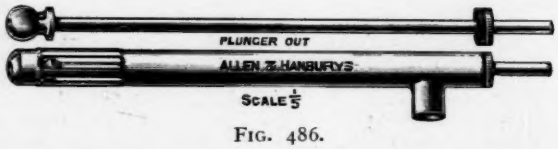


FIG. 486.

If the return should be *partially* blocked by a large clot (I have never found it completely blocked), the inner portion of the instrument can be easily withdrawn without removing the douche as a whole from the uterus.

The blunt end is an ample safeguard against perforating the wall of the uterus.

The instrument is manufactured for me by Messrs. Allen & Hanburys, of Wigmore Street, W.

REVIEWS AND NOTICES OF BOOKS.

The Biology of the Blood-Cells, with a Glossary of Hæmatological Terms, for the use of Practitioners. By O. C. GRUNER, M.D. (Lond.), Montreal. With 7 coloured plates and 75 illustrations. 4to. Bristol and London: John Wright & Sons Ltd. Price 21s. net.

A FULL, detailed and up-to-date work upon the nature and origin of the blood-cells in health and disease: it supplies a real lack in English literature. The present volume may be taken as authoritative. It is perhaps rather a complicated subject to one who has not a fair acquaintance with the general trend of recent work upon the blood, but the reader is assisted by a copious glossary of terms. The surgeon may here find an account of the varieties of blood-cells met with in appendicitis, septicæmia, carcinoma of various organs, syphilis, the splenomegalies, etc.

The book is beautifully illustrated, many hundreds of varieties of cells being represented.

Practical Pathology: Including Morbid Anatomy and Post-mortem Technique. By JAMES MILLER, M.D., D.SC., F.R.C.P.E. Pages xv. and 444. 109 illustrations, with coloured frontispiece. Adam and Charles Black. Price 7s. 6d. net.

THIS small text-book forms a useful practical guide for the student, and its full appendices, dealing with the mounting of museum specimens, microscopic sections, and bacteriological methods, contain a great wealth of information. The illustrations generally are very good, but their grouping at the end of the book is a disadvantage. The figures of common post-mortem technique seem hardly worth reproduction.

International Clinics: A Quarterly Journal of Illustrated Clinical Lectures. Vol. III, 1913. With 2 coloured plates and 55 other illustrations. Pp. vii, and 303. J. B. Lippincott Co. Price 35s. per year.

THIS volume contains a few articles of surgical interest. Two of them, although written by English surgeons on alimentary toxæmia, are placed in the section on medicine. They are enlargements of the contributions made to the subject by their authors before the Royal Society of Medicine. That by Mr. Peter Daniel insists that toxæmia only occurs when septic foci are present, and he attaches great importance to oral sepsis. He fulminates strongly against Lane's theories, but his article would be more weighty if it were more coherent and less heated.

Some interesting cases related by Skillom, a case of fatal osteomyelitis of the lumbar vertebræ by Ashhurst and Wadsworth, and an article on the use of camphorated oil in surgery by Baudet, are among the more interesting surgical papers. Bainbridge contributes an important article on certain electro-therapeutic remedies for malignant disease.

Medical and Surgical Reports of the Episcopal Hospital, Philadelphia: Vol. I, pp. 405, 108 figures. Philadelphia: Wm. J. Dornan.

THIS, the first of its series, opens with about 100 pages descriptive of the hospital, and gives summaries of the year's work done in it in different departments during 1912. The most important paper is by Ashhurst and John on the rational treatment of tetanus, and it has already been summarized in this JOURNAL. The same authors contribute an account of 52 consecutive cases of forearm fractures treated by conservative methods, in which they conclude that in this type of case there is but little need for operation. Other papers of surgical interest are: Fifty-six cases of fractured patella, by Alexander; cases of bone cyst, by Mutschler and Ashhurst; and a case of sarcoma of the appendix, by White. The value of the book is lessened by the fact that most of the important papers in it have already appeared in other American publications.

Clinical Surgical Diagnosis for Students and General Practitioners. By F. DE QUERVAIN, Professor of Surgery and Director of the Surgical Clinic at the University of Basle. Translated from the 4th Edition by J. SNOWMAN, M.D. Large 8vo, 780 pp., with 510 illustrations and 4 plates. Bale, Sons & Danielsson, Ltd. 25s. net.

As would be expected from Professor de Quervain's position and reputation, he has produced an excellent book. Its scope is curtailed by the limitations of those to whom it is addressed—students and general practitioners. Thus, means or methods of diagnosis which are not at their command are not dwelt upon. Professor de Quervain strikes at the root of much medicine when he says, as his translator puts it, "A diagnosis is not to be made merely for its own sake, but as a means of cure." Thus is the book curtailed. Little progress in this world would be made if men were content only to do what is useful. We strive much and accomplish little. But Professor de Quervain's volume must not be judged from a high scientific level. The author himself disclaims such an exalted ideal, and has been content to produce a good practical book, based largely on his own experience. His advice is sound and trustworthy. Such books on surgical diagnosis are not plentiful in our language. The paper and the printing are good, as are also the 509 illustrations, reflecting credit on both author and publisher. Dr. Snowman is to be congratulated upon the success of his work, which should soon call for a second English edition, wherein the few blemishes which appear, such as "the decussation of the large and small intestine," may be removed.

Manual of Surgery: Volume III, Operative Surgery. By ALEXIS THOMSON, Professor of Surgery, University of Edinburgh, and ALEXANDER MILES, Surgeon, Edinburgh Royal Infirmary. Second Edition. Oxford Medical Publications. Pp. xvi. + 599. Price 10s. 6d. net.

THIS book, which has so quickly reached its second edition, is a model of clearness and conciseness. The Basle nomenclature is adopted, showing its authors and publishers to be of advanced views, which will not increase the popularity of the book.

We heartily commend the manner in which the subjects are dealt with, more in proportion to their practical importance than with the requirements of examinations. Modern methods, such as sutures of arteries and aneurysms, and operations upon fractures, are made prominent, whilst the amputations are relegated to their proper place, that is about one-tenth of the whole book.

The drawings are numerous (255) and beautifully clear, the majority being anatomical. There is a commendable absence of pictures from the surgical instrument maker's catalogue.

SHORT NOTICE.

Transactions of the British Proctological Society (1913). Edited by W. S. HANDLEY. Pp 30. H. K. Lewis. Price 2s. 6d.

THIS small paper contains the announcement of the formation of a special society for the study of rectal disease. We greatly doubt whether the formation of such special societies is for the good of surgical science, and we are glad therefore that this new group has already been absorbed by the Surgical Section of the Royal Society of Medicine. The present number contains six original papers, four of which deal with special aspects of rectal carcinoma.

END OF VOLUME I

INDEX TO VOLUME I.

PAGE

ABDOMINAL abnormality, congenital, causing acute obstruction - 645
— operations, statistics of lung complications in - - - - - 599
— ptosis - - - - - - - 507
— retractor, semi-automatic - - 730
— surgery, hedonal anæsthesia in - 100
— and thoracic injuries combined, treatment of - - - - 243
ABERNETHY, JOHN, biographical notes of - - - - - - - - 549
Abnormality, congenital abdominal, causing acute obstruction - 645
Abscess, axillary, mistaken for sarcoma 532
— of lung - - - - - - - 244
— simulated by sarcoma - - - 533
Acholuric jaundice in splenomegaly - 166
Acid intoxication mistaken for intussusception - - - - - 138
Air-passages, foreign bodies in - - 243
Albee's bone-grafting for Pott's disease 512
Alnus glutinosa, effect on cancerous growths - - - - - - 577
Amastia, a case of - - - - - 336
American surgery during the last twelve months - - - - - 502
Amidoazotoluol, causes thickening of Thiersch grafts - - - 513
Amputations, major, mortality in - 502
Anæsthesia and anoci-association - 503
— a criticism of some recent methods - 96
— dangers of, the surgical problem of the future - - - - - 503
— fatal rupture of empyema into bronchus during - - - 323
— hedonal, in abdominal surgery - 100
— — high mortality in - - - 101
— — in intracranial surgery - - 101
— injection of morphine, etc., before, cause of diminution of post-operative bronchial complications - - - - - - 591
— intratracheal - - - - - 90
— — absence of vomiting in - 94, 104
— — advantages of - - - 90, 103
— — emphysema from - - - 503
— — and empyema - - - - 95
— — ether - - - - - - 503
— — Kelly's apparatus for - - 91
— — safety of - - - - - 95
— — technique of - - - 94, 105
— — in thyroid operations - - 94
— intravenous ether - - - - 96
— — — advantages and disadvantages of - - - - 97

PAGE

Anæsthesia, intravenous hedonal - 99
— in marginal resection of tongue - 45
— nitrous oxide-oxygen, in major surgery - - - - - - 108
— in operations for exophthalmic goitre - - - - - - 708
— in thorax operations - - - 239
Analogy of an individual bone with an organ such as the liver, etc. - 624
Anastomosis, absence of, in arterial supply to kidney - - - 17
— arteriovenous femoral, for gangrene 511
— intestinal, in infants - - - 357
— recto-sigmoidal, " critical point " - 681
Anatomy of cleft palate at birth - - 265
— and physiology of speech - - 277
Aneurysm of aorta, partial occlusion by bands for - - - - 511
— leaking, of subclavian artery - 725
— of thoracic aorta, plication for - 511
— traumatic - - - - - - 724
— treated by Matas' method - - 511
Anoci-association - - - - 503
— in thorax operations - - - 239
Anomalies of spleen - - - 168, 169
Anus, mixed carcinoma and epithelioma of - - - - - - 332
— protrusion of vermiform appendix through, in intussusception of latter - - - - - - 721
Aorta, aneurysm of, partial occlusion by bands for - - - - 511
— thoracic, plication of, for aneurysm - 511
Aphasia, traumatic sensory - - 581
— — — previously recorded cases - 585
— — — successfully treated by trephining - - - - - 583
Apical tuberculosis, division of first costal cartilage in - - - 57
— — influence of the first costal cartilage on - - - - - 55
— — its relation to the manubriosternal joint - - - - 65
— — Schmorl's groove - - - 67
Appendices, abnormal, unassociated with gastric symptoms - - 392
Appendicitis, acute, hæmorrhage from ruptured artery in operation for 141
— — mistaken for strangulated hernia 719
— — — traumatic contusion - - 720
— its relation to " dyspepsia," etc. - 390
— simulated by contracture of psoas parvus muscle - - - - 509
Appendicular disease, association with gastric and duodenal ulcers - 397

PAGE

Appendicular dyspepsia - - - 390
— — and pyloric spasm and intestinal stasis - - - - - - 397
— — types of appendix in - - - 396
Appendix, inflammatory tumour of, removed as malignant - - 324
"Appendix tumour," recurrent intussusception - - - - - 722
— types of, in appendicular dyspepsia 396
— vermiformis, intussusception of - 673
— — — with protrusion through anus 721
Architecture of cleft palate in relation to operation - - - - - 269
Arterial supply of the rectum and pelvic colon - - - - - 677
Arteriovenous femoral anastomosis for gangrene - - - - - - 511
Artery, ligation of superior hæmorrhoidal in excision of rectum 681, 685
Arthrodesis of knee-joint - - - 89
Arthroplasty - - - - - - 504
Artificial pneumothorax in phthisis - 506
Ascites, lymphangioplasty in chronic - 507
Aseptic wound-fever and post-operative hyperthyroidism - - - 513
Atresia, congenital, of duodenum- - 508
— — of œsophagus - - - - 507
Atrophy or hypertrophy of osteo-arthritic joints, cause of - - 389
Auto-inoculation due to artificial pneumothorax - - - - - - 231
Autoplastic graft of fibula into humerus after resection for chondro-sarcoma - - - - - 49, 383
Avulsion of tibial spine - - - 73
Axillary abscess mistaken for sarcoma 532

BALLS, porcelain, attached to mops to prevent loss - - - 687
Bands partially occluding aorta, use of, for aneurysm - - - 511
BARLING, GILBERT: Severe unilateral hæmaturia without evident cause - - - - - - 573
BARRINGTON-WARD, L. E.: Congenital enlargement of the colon and rectum - - - - - - 345
Berck-Plage, surgical work at - - 518
BERRY, JAMES: Review of present position of surgical treatment of exophthalmic goitre - - 699
Bile-ducts wounded during cholecystectomy - - - - - - 325
Biliary passages and gall-bladder, an improved route to the - - 200
Biographical Notes:—
John Abernethy - - - - - 549
Sir Astley Paston Cooper, Bart. - 341
John Hunter - - - - - 153
Lord Lister - - - - - 3
Bladder, saccule of, diagnosed as volvulus - - - - - - 323
BLAND-SUTTON, SIR JOHN: Observations on surgery of the spleen - 157

PAGE

Bleeding from kidney, insufficient indication for nephrectomy - - 223
Blood, CO_2 content of, in surgical shock 126
— infections, cause of enlarged spleen 161
— supply of the rectum and pelvic colon - - - - - - 677
Blood-pressure, a guide to operation - 502
BOLT, R. F.: Polycystic disease of the pancreas - - - - - - 142
BOND, C. J.: The late results of transplantation of the fibula, with remarks on the growth and development of transplanted bone - - - - - - 610
Bone, behaviour of isolated fragments 497
— cartilage and the repair of - 496, 500
— cases illustrating the growth and repair of - - - - - - 376
— cavities, filling up with subcutaneous fat - - - - - - 697
— comminuted fracture of, experiments on treatment of - - 471–477
— — — value of indirect fixation in - 477
— dense, function in bone repair - 491
— disease, Koehler's - - - - 504
— formation of, in human penis - - 513
— an individual, its analogy with an organ such as the liver, etc. - 624
— operations on premaxilla in cleft palate - - - - - - 291
— parts played by periosteum, medulla, and dense bone in repair of 492
— regeneration of, and callus formation - - - - - - - 491
— relative value of one large or several small grafts in repair of - - 483
— repair of, after subperiosteal removal 479–482
— transplanted, growth and development of - - - - 610, 619
— tuberculous abscess of - - - 525
Bone-fracture, conditions in animals and man not analagous - - 485
— factors determining success in operative treatment - - - 485
— fixation by intramedullary pegs 453–467
— — metal collars - - - - 451
— — plates and screws or pins - 441–450
— indirect fixation in comminuted and compound - - - 489, 490
— — — by transfixion and extension apparatus - - - 467
— methods and material used in experiments - - - - - 442
— tibia of cat suitable for experiments 440
Bone-grafting of tibia on ulna for endothelioma - - - - 434
— Albee's, for Pott's disease - - 512
— of humerus for chondro-sarcoma - 383
— leg fourteen years ago, results of - 381
— observations on - - - - 49
— relative advantages of autoplasty, homoplasty, and heteroplasty - 49
— in skull, different behaviour according to size of grafts - - - 378

PAGE

BRAITHWAITE, L. R. and COLLINSON, H.: Division of duodenum at the duodeno-jejunal junction treated by closure of the ends and gastro-jejunostomy - - 665
Breast, tumours of male - - - 505
Bronchial complications, post-operative, diminution of, after injection of morphine, etc., before anæsthetizing - - - - 591
Bronchiectasis, surgical treatment - 248
Bronchitis, chondrectomy for - - 257
— ether, due to septic saliva - - 94
Bronchoscope for foreign bodies - - 243
Bronchus, fatal rupture of empyema into - - - - - - - 323
Brophy's operation for cleft palate 282, 295
BRYAN, C. W. G.: Condyle of humerus, epiphysis displaced into elbow-joint - - - - - - 534
BURGHARD, F. F.: Intussusception of the vermiform appendix - - 721
Butlin's operation of marginal resection of the tongue, technique - - 42

CÆCUM, volvulus of, causing acute obstruction - - - - - 644
Calcification of pleura, surgical treatment 240
Calculus of kidney, nephrectomy for - 216
— recurrence of, in litholapaxy - - 415
— vesical, radiography in - - - 414
— — symptoms and signs - - - 413
Callus, amount, position, origin, and constitution of - - - - 495
— formation and regeneration of bone 491
Cancer, rectal, intramural extension in 173
Cancerous growths treated by alnus glutinosa - - - - - 577
Carbon dioxide content of the blood in surgical shock - - - 126
Carcinoma mastoides - - - - 504
— of œsophagus, resection for - - 508
— Vater's papilla - - - - - 508
Caries of spine - - - - - - 521
CARLESS, ALBERT: Case of perineo-scrotal dermoid cysts - - 39
Cartilage and bone-repair - - 496, 500
— first costal, influence of on apical tuberculosis - - - - 55
Cat's tibia suitable for experiments on bone-fracture - - - - 440
Cavities, bone, filling up with subcutaneous fat - - - - 697
Chest, concussion of - - - - 242
— wall, sarcoma of - - - - 505
Cholecystectomy, bile-ducts wounded during - - - - - - 325
Cholecystotomy, first successful case by Lawson Tait - - - - - 23
Chondrectomy for bronchitis and emphysema - - - - - 257
Chondro-sarcoma, autoplastic graft of fibula into humerus after resection for - - - - - 49, 383

PAGE

Chronic osteomyelitis, radical operation for - - - - - - 625
Clamp for crushing intestine - - 542
Clavicle, good functional results after excision of - - - - - 404
— thyroid tumour of - - - - 401
Cleft-palate, advantages and disadvantages of different operations - 296
— — — early and late operation 299, 300
— anatomy at birth - - - - 265
— — and treatment of - - - 259
— architecture relative to operation - 269
— best time and method of operation - 305
— bone operations on premaxilla - 291
— Brophy's operation - - 282, 295
— Griffith's operation - - 282, 295
— growth of segments before birth - 262
— Lane's operation - - - 270, 283
— Langenbeck's operation - - 269, 288
— — — proper time for - - - 303
— list of cases - - - - - - 307
— measurements - - 264, 265, 275
— operative treatment - - - 281
— post-natal development of growth - 267
— results of operative treatment - 295
— secondary operations - - - 293
— varieties - - - - - - 259
Clinics, surgical, at home and abroad (*see* Surgical Clinics)
Coley's serum, cure of sarcoma of femur by - - - - - 504
Collapse, active lobar, of lung - - 587
— massive, of lung - - - - 587
— — — clinical features of - - 592
— — — diagnosis and treatment of - 595
— — — following operation - - 590
— — — from respiratory paralysis - 588
— treatment by, in lung diseases - 228
COLLINSON, H. and BRAITHWAITE, L. R.: Division of duodenum at the duodeno-jejunal junction treated by closure of the ends and gastro-jejunostomy - - 665
Colon, congenital idiopathic dilatation of - - - - - - - 345
— pelvic, and rectum, arterial supply of - - - - - - - 677
— physiological rest in affections of - 510
— and rectum, congenital enlargement 345
COLT, G. H.: Portable operation theatre 145
Complications following operations - 502
— lung, in abdominal operations - 599
— post-operative bronchial, diminution of, after injection of morphine before anæsthetizing - 591
Concussion of chest - - - - 242
Condyle of humerus, epiphysis displaced into elbow-joint - - 534
Congenital abdominal abnormality causing acute obstruction - 645
— absence of the fibula - - - 203
— atresia of duodenum - - - 508
— — œsophagus - - - - 507
— dilatation of colon and rectum (*see* Hirschsprung's Disease)

PAGE

Congenital elevation of scapula, cause of - - - - - - 553
— — — prognosis and treatment - 570
— — — a series of cases and a description of a dissected specimen - - - 553
— enlargement of colon and rectum - 345
— idiopathic dilatation of colon - - 345
— pyloric stenosis simulated by Hirschsprung's disease - - - 349
— radio-ulnar synostosis - - - 366
— — — advisability of operation 368, 374
— — — clinical features - - - 366
— — — etiology - - - - - 372
— — — hereditary element in - - 366
— — — morbid anatomy - - - 367
— — — treatment - - - - - 374
— — — types of - - - - - 367
Connective tissue, organized, loose bodies in the knee - - - 653
Conservative treatment in renal hæmaturia - - - - - - - 573
Control of renal hæmorrhage in nephrotomy - - - - - 573
Contusion of abdomen simulating acute appendicitis - - - 720
Cooper, Sir Astley Paston, Biographical notes of - - - 341
Cope, V. Zachary: Traumatic sensory aphasia - - - - - 581
Corner, Edred M.: Clinical picture of congenital absence of fibula - 203
— — note on unreliability of microscopic evidence in malignant disease - - - - - 580
Corpora oryzoidea - - - - - 652
Costal cartilage, first, division in apical tuberculosis - - - - - 57
— — — — for phthisis - - 57, 252
— — — influence of, on apical tuberculosis - - - - - 55
— — — its relation to apical tuberculosis, Freund's theory 60, 252
Crises, gastric, in tabes dorsalis, rhizotomy for - - - - - 512
"Critical point," recto-sigmoidal anastomosis - - - - - 681
Crucial ligaments of the knee, rupture of 70
Cystoscopy, importance of, in litholapaxy - - - - - 415, 417
Cysts, dermoid, perineo-scrotal - - 39

DANGERS of anæsthesia, the surgical problem of the future - - 503
— of operations for Graves's disease 706
Davies, H. Morriston: The influence of the first costal cartilage on apical tuberculosis - - - 55
— — recent advances in the surgery of the lung and pleura - - 228
Decompression, sellar, case of - - 183
Dermoid cysts, perineo-scrotal - - 39
Development and growth of transplanted bone - - - 610, 619

PAGE

Diaphysis of humerus, excision of, with full functional recovery - 632
Dighton, Adair: Sarcoma of the nose 207
Diminution of post-operative bronchial complications after injection of morphine before anæsthetizing - 591
Displacement of intestines - - - 537
Dissected specimen of congenital elevation of scapula, description of - 553
Diverticulitis of the sigmoid - - 509
Division of duodenum, closure of the ends and gastro-jejunostomy - 665
Douche, intra-uterine - - - - 730
Don, Alexander: Unusual displacement of intestines - - - 537
Drainage after operation for lung injuries - - - - - - 243
"Drowning" caused by intravenous infusion - - - - - - 98
Drummond, Hamilton: Arterial supply of the rectum and pelvic colon - - - - - - 677
Duodenal ulcer, association with appendicular disease - - - - 397
— — simulated by ruptured tubal pregnancy - - - - 528
Duodenum, congenital atresia of - - 508
— diseases of, relation of appendicitis to - - - - - - - - 390
— division of, closure of ends and gastro-jejunostomy for - - 665
— excision of ulcers of - - - 509
Dyspepsia, appendicular - - - 390
— — and pyloric spasm and intestinal stasis - - - - - - 397
— — types of appendix in - - - 396
— persistent, due to intestinal stasis - 395
— etc., relation of appendicitis to - 390

ECHINOCOCCUS disease of spleen 163
Eclampsia, "pleural," in artificial pneumothorax - - - - - 230
Effusion, pleural, after artificial pneumothorax - - - - - 232
Egyptian splenomegaly, splenectomy in - - - - - 419, 428
Elbow-joint, displacement of epiphysis of internal condyle of humerus into - - - - - - - - 534
Elevation of scapula, congenital, cause of - - - - - - - - 553
— — — prognosis and treatment - 570
— — — a series of cases and a description of a dissected specimen - - - - 553
— — importance of differentiating between acquired and congenital - - - - 553, 570
Elkin, S. J. and Halpenny, Jasper: Typhoid spine, a report of two cases and a short review - - 602
Embolus, nitrogen, in artificial pneumothorax - - - - - - 230
Embryonic shortness of intestine - - 537

PAGE
Emphysema, chondrectomy for - - 257
— from intratracheal anæsthesia - 503
— surgical, in lung injuries- - - 242
Empyema, chronic, rib mobilization (Pfeiler resektion) for - - 240
— fatal rupture of into bronchus - 323
— and intratracheal anæsthesia - - 95
— surgical treatment of - - - 239
Endothelioma of ulna, bone-graft for - 434
Enlargement, congenital, of colon and rectum - - - - - - 345
Enteritis, infantile, simulated by intussusception - - - - - 139
Epiphysis of internal condyle of humerus, displacement of into elbow-joint - - - - - 534
— lower femoral, separation of - - 503
Epithelioma simulated by ulceration of nose - - - - - - 576
Erb's paralysis, traumatic, operative intervention in - - - - 512
"Essential" hæmaturia - - - 4
Ether anæsthesia, infusion, in thorax operations - - - - - 239
— — intratracheal - - 90, 101, 503
— — intravenous - - - - - 96
— — — advantages and disadvantages of - - - - 97
— bronchitis due to septic saliva - 94
EVANS, ARTHUR J.: Excision of diaphysis of humerus with full functional recovery - - 632
Excision, high, of rectum, gangrene after - - - - - - 681, 685
— of lower end of humerus - - 387
— of rectum, importance of abdominal ligation of superior hæmorrhoidal artery in - - 681, 685
Exophthalmic goitre (*see also* Graves's Disease)
— — anæsthesia in operations for - 708
— — choice of operation for - - 702
— — indications for operation and selection of cases - - 701
— — ligation of thyroid arteries for - 704
— — results of operation for - - 710
— — surgical treatment of - - 699
Exothyropexy - - - - - - 702
Extirpation of lung - - - - 252
— partial, of thyroid - - - 703

FAIRBANK, H. A. T.: Congenital elevation of the scapula: a series of cases, with description of a dissected specimen - - 553
Fat, subcutaneous, use of, to fill up bone cavities - - - - - 697
Femoral arteriovenous anastomosis for gangrene - - - - - - 511
— epiphysis, separation of lower - 503
Femur, fracture of, indirect fixation in 478
— gummatous, fracture of - - - 376
— sarcoma of, cured by Coley's serum 504
Fibrinous loose bodies in the knee - 652
PAGE
Fibroma, tumour of vagus removed in mistake for - - - - - 329
Fibrosis, hypertrophic, of gut after strangulated hernia - - - 361
Fibula, congenital absence of - - 203
— graft of, into humerus after resection for chondrosarcoma - 49, 383
— late results of transplantation of - 610
Fibulæ, absence of, etc. - - - - 144
First costal cartilage, influence of on apical tuberculosis - - - 55
Fistula, gastro-colic, resection, and death from shock - - - 327
— urinary, nephrectomy for - - 222
Fixation, operative, causing delay in union of fractures - - - 503
Fœtal limb development in radio-ulnar synostasis - - - - 372
— peritoneal folds - - - - - 509
Foreign bodies in air-passages and lungs - - - - - - - 243
Fossa, paraduodenal, hernia into, cause of acute obstruction - 648
Fracture, combined, of tibial spine and tuberosity - - - - 84
— of external tubercle of tibial spine - 81
— gummatous femur - - - - - 376
— operative fixation causing delay in union - - - - - - 503
— — treatment of - - - - - 439
— — — Dr. Lambotte's - - - 317
— — — Sir Arbuthnot Lane's - - 314
— of the spine of the tibia - - - 70
Freund's theory on relation between apical tuberculosis and first costal cartilage - - 60, 252
FULLERTON, ANDREW: Forty-eight successive cases of nephrectomy 211
"Functional" hæmaturia - - - 4

GALL-BLADDER and biliary passages, an improved route to 200
— operations on - - - - - 27
Gall-stones, statistics of operations - 32
— history of - - - - - - 22
— a plea for earlier operation in - 21
Gangrene, arteriovenous femoral anastomosis for - - - - - - 511
— after high excision of rectum - 681, 685
— of lung - - - - - - - 244
GARRÉ, PROFESSOR: Clinic at Bonn - 695
Gases in pleural cavity, therapeutic use of - - - - - - - 229
GASK, G. E.: Autoplastic graft of fibula into humerus after resection for chondro-sarcoma - - - - 49
Gastric crises in tabes dorsalis, rhizotomy for - - - - - - 512
— ulcers, association with appendicular disease - - - - - 397
Gastro-colic fistula, resection of, and death from shock - - - 327
Gastro-jejunal ulcer, gastro-jejunostomy for - - - - - 671

PAGE

Gastro-jejunostomy and closure of the ends for division of the duodenum at the duodeno-jejunal junction - - - 665
— for jejunal or gastro-jejunal ulcer - 671
Glands, tuberculous - - - - 526
Glioma, large, with slight symptoms, case of - - - - - - 183
GODLEE, SIR RICKMAN J.: Introduction 1
Goitre, exophthalmic, anæsthesia in operations for - - - 708
— — choice of operation for - - 702
— — indications for operation and selection of cases - - 701
— — ligation of thyroid arteries for - 704
— — results of operation for - - 710
— — surgical treatment of - - 699
GOYDER, FRANCIS W.: The anatomy and treatment of cleft palate - 259
Graft of fibula into humerus after resection for chondro-sarcoma 49, 383
Grafting of bone 378, 381, 383, 434, 483, 512
— of tibia for tuberculosis - - 378
Grafts, Thiersch, thickened by use of amido-azotoluol - - - 513
Graves's disease, dangers of operations for - - - - - - 706
— — rôle of thymus in - - - 705
— — (*see also* Exophthalmic Goitre)
GRAY, H. M. W.: An improved route of approach to the gall-bladder and biliary passages - - - 200
Griffiths' operation for cleft palate 282, 295
GROVES, ERNEST W. HEY: Experimental study of the operative treatment of fractures - - 438
— — unusual case of syndactylism - 143
— — absence of both fibulæ - - 144
Growth and development of transplanted bone - - - 610, 619
— of loose bodies in the knee - - 650
— and repair of bone, cases illustrating 376
Gummatous femur, fracture of - - 376
Gunshot-wounds of spleen - - - 159

HÆMATURIA, "essential" - - 4
— "functional" - - - - - 4
— from pressure on renal veins - - 5
— renal, conservative treatment in - 573
— — insufficient indication for nephrectomy - - - - 223
— — symptomless - - - 4, 573
— — severe unilateral, without evident cause - - - 573
— from torsion of renal veins - - 5
"Hæmophilia, renal" - - - 573
Hæmorrhage, from deep epigastric vein in hernia operation - - - 140
— renal, control of, in nephrotomy - 573
— from ruptured ileocolic artery in operation for acute appendicitis 141
Hæmorrhoidal artery, superior abdominal ligation of, in excision of rectum - - - 681, 685

PAGE

HALPENNY, JASPER, and ELKIN, S. J.: Typhoid spine, a report of two cases and a short review - - 602
Hand, plastic operation on - - 727
HANDLEY, SAMPSON: Butlin's operation of marginal resection of tongue 42
Handley's method of lymphangioplasty 505
Heart, suture of - - - - 510
Hedonal anæsthesia in abdominal surgery - - - - - - 100
— — high mortality in - - - 101
— — in intracranial surgery - - 101
— — intravenous - - - - 99
Hernia, intersigmoid, causing acute obstruction - - - - 647
— into the paraduodenal fossa, causing acute obstruction - - 648
— strangulated, causing fibrosis of gut and obstruction - - - 361
— — simulated by acute appendicitis - - - - - 719
— transplantation of rectus in operations for - - - - - 510
HIGGINS, T. TWISTINGTON, and NABARRO, DAVID: Obscure case of ulceration of nose (probably tuberculosis verrucosa cutis) simulating epithelioma - 576
Hirschsprung's disease - - - 345
— — clinical features of - - - 350
— — diagnosis of - - - - 353
— — etiology of - - - - 347
— — intestinal exclusion in - - 354
— — post-mortem records of - - 358
— — rectum dilated in - - - 347
— — resemblance to congenital pyloric stenosis - - - - 349
— — surgical better than medical treatment - - - - 354
— — treatment of - - - - 353
HORSLEY, SIR VICTOR: Clinic at the National Hospital for the Paralyzed and Epileptic - - - 515
Humerus, autoplastic graft of fibula into, after resection for chondro-sarcoma - - - - 49, 383
— bone-grafting of for chondro-sarcoma - - - - - 383
— displacement of epiphysis of internal condyle of into elbow-joint - 534
— excision of diaphysis of, with full functional recovery - - - 632
— — lower end of - - - - 387
HUNTER, JOHN, biographical notes of 153
Hydronephrosis, nephrectomy for - 218
Hyperæmia, renal, causing symptomless renal hæmaturia - - 4
Hyper-atmospheric method in open pneumothorax - - - - 237
Hyperthyroidism, post-operative, and aseptic wound-fever - - 513
Hypertrophy or atrophy of osteo-arthritic joints, cause of - - 389
Hypo-atmospheric method in open pneumothorax - - - - 237

PAGE

Hypodermic injection in shock - - 122
Hypophysis cerebri, (*see also* Pituitary Gland)
— — operations on - - - - 193
— — — results of - - - - 196
— — — routes in - - - 191, 195

ILEAL kink - - - - 366, 369
Infants, intestinal anastomosis in - 357
Infantile enteritis simulated by intussusception - - - - 139
Inflammatory tumour of appendix removed as malignant - - - 324
Influence of the first costal cartilage on apical tuberculosis - - 55
Infusion, intravenous, "drowning" caused by - - - - 98
Injection, hypodermic, in shock - - 122
Injured ligaments, necessity of prolonged rest - - - - 87
Injury of pancreas, cases of - - 637
Instructive Mistakes:—
Acid intoxication mistaken for intussusception - - - 138
Acute appendicitis mistaken for strangulated hernia - 719
— — mistaken for traumatic contusion - - - 720
Appendix, inflammatory tumour of, removed as malignant - 324
Axillary abscess mistaken for sarcoma - - - - - 532
Bile-ducts wounded during cholecystectomy - - - - 325
Bladder, saccule of, diagnosed as volvulus - - - - 323
Duodenal ulcer and (undiagnosed) ruptured tubal pregnancy - 528
Empyema, fatal rupture of, into bronchus - - - - 323
Frontal mucocele mistaken for sarcoma - - - - 718
Gastro-colic fistula, resection of, and death from shock - - 327
Hæmorrhage from ruptured ileo-colic artery in operation for acute appendicitis - - 141
Internal hæmorrhage from deep epigastric vein in hernia operation - - - - - 140
Intussusception mistaken for infantile enteritis - - - 139
Pregnancy, ruptured tubal, diagnosed as duodenal ulcer - 528
Sarcoma mistaken for abscess - 533
— — for innocent tumour - - 529
Vagus, tumour of, removed in mistake for fibroma - - 329
Insufflation in open pneumothorax - 238
Intersigmoid hernia, causing acute obstruction - - - - 647
Intestinal anastomosis in infants - 357
— crushing clamp - - - - 542
— exclusion in Hirschsprung's disease 354

PAGE

Intestinal obstruction, acute, due to congenital abdominal abnormality - - 645
— — — — hernia into the paraduodenal fossa - - 648
— — — — intersigmoid hernia - 647
— — — — rare causes - - - 644
— — — — volvulus of the cæcum - 644
— stasis, cause of appendicular dyspepsia - - - - - 395, 397
Intestine, embryonic shortness of - 537
— hypertrophic fibrosis of, after strangulated hernia - - - 361
— trough for evacuating - - - 541
— unusual displacement of - - 537
Intracranial surgery, hedonal anæsthesia in - - - - - - - 101
Intramural extension in rectal cancer 173
Intratracheal anæsthesia - - 90, 503
— — absence of vomiting in - 94, 104
— — advantages of - - - 90, 103
— — emphysema from - - - 503
— — and empyema - - - - 95
— — Kelly's apparatus for - - 91
— — safety of - - - - - - 95
— — technique of - - - 94, 105
— — in thyroid operations - - 94
Intravenous ether anæsthesia - - 96
— — — advantages and disadvantages of - - - - - 97
— hedonal anæsthesia - - - 99
— infusion, "drowning" caused by - 98
Introductory (Sir Rickman J. Godlee) - 1
Intussusception mistaken for infantile enteritis - - - - - 139
— progress in treatment of - - 509
— recurrent, "appendix tumour" - 722
— of vermiform appendix in adult 673, 721
— — — with protrusion through anus 721
— simulated by acid intoxication - 138

JAUNDICE, acholuric, in splenomegaly - - - - - - - 166
Jejunal ulcer, gastro-jejunostomy for - 671
Joint disease, tuberculous - - 523, 525
Joints, osteo-arthritic, cause of atrophy or hypertrophy in - - - 389
JONES, ROBERT, and SMITH, S. ALWYN: On rupture of the crucial ligaments of the knee, and fractures of the spine of the tibia - - 70

KELLY, ROBERT E.: Intratracheal anæsthesia - - - - - 90
— apparatus for intratracheal anæsthesia - - - - - - 91
Kidney, absence of anastomosis in arterial supply of - - - 17
— bleeding from, insufficient indication for nephrectomy - - - 223
— calculus of, nephrectomy for - - 216
— importance of examining each, before nephrectomy - - 212, 216

PAGE

Kidney, the painful, not always the diseased - - - - - - 223
— tuberculosis of, nephrectomy for - 213
— tumours of, nephrectomy for - - 220
— — stoutness of patients with- - 222
— urinary deposit in both - - - 334
Knee, loose bodies in, composed of organized connective tissue - 653
— — — and their etiology and growth - - - - - 650
Knee-joint, arthrodesis of - - - 89
— rupture of the crucial ligaments of - 70
Knife for skin different from that used for deep parts - - - - 690
Koehler's bone disease - - - 504

LAMBOTTE, DR.: Clinic at Antwerp 31
LANE, SIR ARBUTHNOT: Clinic at Guy's Hospital - - - 314
— operative treatment of fractures - 314
— operation for cleft palate - 270, 283
Langenbeck's operation for cleft palate 269, 288
— — proper time for performing - 303
Laryngectomy for cancer - - - 505
Larynx, laryngectomy for cancer of - 505
Late results of transplantation of the fibula - - - - - - 610
Leg, results of bone-grafting fourteen years ago - - - - - - 381
Leukæmic spleen, splenectomy fatal in 157, 165, 169
Ligaments, injured, necessity of prolonged rest for - - - - 87
— of the knee, rupture of - - - 70
Ligation, abdominal, of superior hæmorrhoidal artery in excision of rectum - - 681, 685
— of thyroid arteries for exophthalmic goitre - - - - - - 704
LISTER, LORD, biographical notes of - 3
Litholopaxy - - - - - - 406
— contraindications - - - - 415
— disabilities compared with lithotomy 415
— importance of cystoscopy in 415, 417
— indications for - - - - 414
— methods of performing - - - 417
— recurrence of calculus after - - 415
Lithotomy, disabilities compared with litholopaxy - - - - 415
Lithotrity, history of - - - - 406
Lobar, active, collapse of lung - - 587
Lobe of lung, amputation of, in bronchiectasis - - - - - - 248
Loose bodies, fibrinous, in the knee - 652
— — in knee composed of organized connective tissue - - 653
— — — and their etiology and growth 650
Lung, abscess of - - - - - 244
— active lobar collapse of - - - 587
— collapse of, caused by division of phrenic nerve - - - - 250
— complications in abdominal operations, statistics of - - - 599

PAGE

Lung diseases, oxygen replacement in 235
— — treatment by collapse - - 228
— extirpation of - - - - 252
— foreign bodies in - - - - 243
— gangrene of - - - - - 244
— injuries, absolute rest in - - - 243
— massive collapse of - - - - 587
— — — clinical features - - - 592
— — — diagnosis and treatment of - 595
— — — following operation - - 590
— — — from respiratory paralysis - 588
— — causes of - - - - - 241
— — conservative treatment in - - 242
— — drainage after operation for - 243
— — escape of air into mediastinum 242
— — indications for operation - - 242
— — ingravescent pneumothorax in - 242
— — pleural reflex in - - - 242
— — surgical emphysema in - - 242
— — — treatment of - - - - 241
— methods of producing solidification of 246
— and pleura, the surgery of - - 228
— primary malignant tumours of - 253
— streptotrichosis of, stages of - - 253
— — surgical treatment - - - 252
— surgery of, shock abolished in - 256
— syphilis of, surgical treatment - 252
— tuberculosis of, nitrogen displacement for - - - - 229
— — surgical treatment - - 229, 250
— value of *x*-rays in surgery of - - 228
Lymphangioplasty - - - 505, 507

MACEWEN, SIR WILLIAM: University Clinic, Glasgow - - - 128
Major surgery, nitrous oxide-oxygen anæsthesia in - - - - 108
Malarial spleen - - - - - 162
— — spontaneous rupture of - - 506
Malignant disease, unreliability of microscopic evidence in - - - 580
Mammary gland, operations on - - 505
Manometer, water, in artificial pneumothorax - - - - - 230
Manubrio-sternal joint, influence on apical tuberculosis - - - 65
Marginal resection of tongue, anæsthesia in - - - - - 45
— — — Butlin's operation of - - 42
MARNOCH, JOHN: Cases of acute intestinal obstruction due to rare causes - - - - - 644
Massive collapse of lung (active lobar collapse) - - - 587
— — — clinical features of - - 592
— — — diagnosis and treatment of - 595
— — — following operation - - 590
— — — from respiratory paralysis - 588
Matas' method of treating aneurysm - 511
M'CONNELL, R. J., and WILSON, W.: Intussusception of the vermiform appendix - - - - 673
MAKINS, G. H.: Mixed carcinoma and epithelioma of the anus - - 332

PAGE

Mechanism of respiration - - - 587
Mediastinum: "to-and-fro flapping" in open pneumothorax - - 237
— escape of air into, from lung injuries 242
Medulla of bone and bone repair - - 491
Membranous pericolitis and allied conditions - - - - 509
Methods of anæsthesia, a criticism of 96
Microscopic evidence, unreliability of, in malignant disease - - - 580
Mistakes at operations, affected side of patient previously marked with cross to prevent - - - 688
MONSARRAT, K. W., and WILLIAMS, IDWAL J.: intramural extension in rectal cancer - - - 173
Mouth and tongue, malignant disease of 507
MOORE, C. A.: Fibrosis of gut causing chronic obstruction after strangulated hernia - - - - 361
MORISON, RUTHERFORD: Aneurysms - 724
— — cases illustrating the principles of growth and repair in bone 376
— — clinic at Newcastle-upon-Tyne - 686
— — plastic operation on the hand - 727
MORITZ, MANFRED: Factors involved in operations on the hypophysis cerebri - - - - - - 193
Morphine, etc., injection of before anæsthetizing causes diminution of bronchial complications - 591
Mortality-rate, disproportionate, in gall-stone operations - - - 21
Movable spleen - - - - - - 160
Mucocele, frontal, mistaken for sarcoma 718
Myeloid sarcoma of tibia - - - 387
Myositis ossificans traumatica - - 503

NABARRO, DAVID, and HIGGINS, T. TWISTINGTON: Obscure case of ulceration of nose (probably tuberculosis verrucosa cutis) simulating epithelioma - - 576
Nephrectomy, bleeding from kidney insufficient indication for - - 223
— for calculus of kidney - - - 216
— forty-eight successive cases of - 211
— for hydronephrosis - - - - 218
— importance of examining both kidneys before - - - 212, 216
— for kidney tumours - - - 220
— persistence of sinus after - - 215
— for pyelonephritis without calculus 217
— for tuberculous kidney - - - 213
— for urinary fistula - - - - 222
— importance of ascertaining sp. gr. of urine in - - - - - - 212
Nephrotomy, control of renal hæmorrhage in - - - - - - 573
NEWBOLT, G. P.: Urinary deposit in both kidneys - - - - - 334
New Instruments and Appliances:—
An intestinal crushing clamp - 542
A portable operation theatre - 145

PAGE

New Instruments and Appliances, contd.—
Intra-uterine douche - - - - 730
Semi-automatic abdominal retractor - - - - - - - 730
Trough for evacuating intestines - 541
NEWMAN, DAVID: Symptomless renal hæmaturia - - - - - - 4
Nitrogen displacement for tuberculosis of lung - - - - - 229
— embolus, in artificial pneumothorax 230
— pneumothorax in phthisis - - 232
Nitrous oxide-oxygen anæsthesia, use in major surgery - - - - - 108
Nose, obscure case of ulceration of, simulating epithelioma - - 576
— sarcoma of - - - - - - - 207
Novocain in artificial pneumothorax - 230
— injection to abolish shock in surgery of lung - - - - - - - 256
— in thorax operations - 239, 256, 257

OBESITY a feature in patients with tumours of kidney - - - - 222
Obscure case of ulceration of the nose, simulating epithelioma - - 576
Obstruction, acute intestinal, due to congenital abnormality - - 645
— — — — hernia into the paraduodenal fossa - 648
— — — — intersigmoid hernia - 647
— — — — rare causes - - - 644
— — — — volvulus of the cæcum - 644
— chronic, of intestine caused by fibrosis - - - - - - 361
Occlusion, partial, of aorta by bands for aneurysm - - - - - - 511
Œsophagus, congenital atresia of - 507
— resection of, for carcinoma - - 508
Operating theatre, portable - - 145
Operation, abdominal, lung complications in - - - - - - 599
— complications following - - - 502
— diminution of bronchial complications following, after injection of morphine, etc. - - - - 591
— for exophthalmic goitre, anæsthesia in - - - - - - 708
— — — choice of - - - - - 702
— — — dangers of - - - - - 706
— — — indications for - - - - 701
— — — results of - - - - - 710
— on the gall-bladder - - - - 27
— — hypophysis cerebri - - - 193
— massive collapse of lung following - - - - - - - - 590
— patient previously marked to prevent mistakes at - - - - - 688
— plastic, on hand - - - - - 727
Os calcis, tuberculous disease of - - 535
Osteoarthritic joints, cause of atrophy or hypertrophy in - - - - 389
Osteomyelitis, chronic, radical operation for - - - - - - 625
Oxygen replacement in lung diseases - 235

PAGE

PALATE, Cleft (*see* Cleft Palate)
Pancreas, injuries of - - - 507
— polycystic disease of - - - 142
Pancreas, injury of - - - - 637
Papilla, Vater's, carcinoma of - - 508
Paraduodenal fossa, hernia into, causing acute obstruction - - - 648
Paralysis, Erb's traumatic, operative intervention in - - - - 512
— respiratory, cause of massive collapse of lung - - - - - - 588
PASTEUR, W.: Massive collapse of the lung (active lobar collapse) - 587
Pelvic colon and rectum, arterial supply of - - - - - - - 677
Pericolitis, membranous, and allied conditions - - - - 509
Perineo-scrotal dermoid cysts - - 39
Periosteum and bone-repair - - 491
Peritoneal folds, fœtal - - - 509
Penis, human, formation of bone in - 513
Perthes's incision - - - - - 200
"Pfeiler resektion" (rib mobilization) of Wilms - - - - 240, 252
— — in chronic empyema - - - 240
Phrenic nerve, division of, to induce collapse of lung - - - 250
Phthisis (*see also* Tuberculosis)
— peribronchial, in earliest stage - 252
— treated by artificial pneumothorax 229, 506
Physiology and anatomy of speech - 277
Pituitary body (*see* Hypophysis cerebri)
— enlargements, comparison with those of thyroid - - - 190, 193
Plastic operation on hand - - - 727
Pleura, calcification of, surgical treatment - - - - - - 240
— parietal, anæsthetized to prevent "pleural reflex" - - - - 230
— primary malignant tumours of - 253
— surgery of - - - - - - 228
Pleural cavity, therapeutic use of gases in - - - - - - 229
— "eclampsia," in artificial pneumothorax - - - - - - 230
— effusion after artificial pneumothorax 232
— "reflex" in artificial pneumothorax 230
— — in lung injuries - - - - 242
— — prevented by using novocain - 230
Plication of thoracic aorta for aneurysm 511
Pneumothorax, artificial, auto-inoculation resulting from - - 231
— — nitrogen embolus in - - - 230
— — "pleural eclampsia" in - - 230
— — pleural effusion after - - 232
— — "pleural reflex" in - - - 230
— — in phthisis - - - 229, 506
— — water manometer in - - - 230
— ingravescent, in lung injuries - - 242
— open, hyper-atmospheric method in 237
— — insufflation in - - - - - 238
— — and its mechanical control - 236
— — mediastinal "to-and-fro flapping" 237
— — hypo-atmospheric method in - 237

PAGE

Polycystic disease of pancreas - - 142
Porcelain balls attached to mops to prevent their loss - - - - 687
Post-operative bronchial complications, diminished by injection of morphine, etc., before anæsthetizing 591
— massive collapse of lung - - - 590
Pott's disease, Albee's bone-grafting for 512
POWER, D'ARCY: Gall-stones: a plea for earlier operation - - - 21
Pregnancy, ruptured tubal, mistaken for duodenal ulcer - - - 528
Premaxilla, bone operations on, in cleft-palate - - - - - 291
PRINGLE, SETON: Radical operation for chronic osteomyelitis - - 625
Psoas parvus muscle, contracture of, simulating appendicitis - - 509
Ptosis, abdominal - - - - - 507
Pulmonary artery, ligature of branch for bronchiectasis - - - 249
— surgery, *x*-rays in - - - - 228
— tuberculosis (*see also* Phthisis)
— — division of 1st costal cartilage 57, 252
— — nitrogen displacement for - - 229
— — rib mobilization in - - - 252
— — surgery of - - - 229, 250
Pyelonephritis without calculus, hypernephrectomy for - - - - 217
Pyloric spasm, cause of appendicular dyspepsia - - - - - - 397
— stenosis, congenital, simulated by Hirschsprung's disease - - 349
Pyonephrosis not due to calculus, nephrectomy for - - - 218

RADICAL operation for chronic osteomyelitis - - - 625
Radiography in vesical calculus - - 44
Radio-ulnar synostosis (*see* Congenital radio-ulnar synostosis)
Radius, radio-ulnar synostosis with dislocation of head of - - - 368
RADLEY, S. B. and DUGGAN, W.: Thyroid tumour of clavicle treated by operation - - 401
Rare or Obscure Cases:—
Absence of both fibulæ, etc. - - 144
Amastia, a case of - - - 336
Aneurysms - - - - - - 724
Anus, mixed carcinoma and epithelioma of - - - - - 332
Displacement into elbow-joint of epiphysis of internal condyle of humerus - - - - - - 534
Intussusception of vermiform appendix, the intussusceptum protruding through the anus - 721
Kidneys, urinary deposit in both - 334
Plastic operation on hand - - 727
Polycystic disease of pancreas - 142
Recurrent intussusception, "appendix tumour" - - - 722
Syndactylism - - - - - 143

PAGE

Rare or Obscure Cases, continued—
Tuberculous disease of the os calcis 535
Unusual displacement of intestines 537
Rare causes, cases of acute intestinal obstruction due to - - - 644
Rectal cancer, intramural extension in 173
— dilatation in Hirschsprung's disease 347
Recto-sigmoidal anastomosis, "critical point" - - - - - - 681
Rectum and colon, congenital enlargement of - - - - - - 345
— excision of, importance of abdominal ligation of superior hæmorrhoidal artery in - - - - 681, 685
— — gangrene after high - - 681, 685
— and pelvic colon, arterial supply of - 677
Rectus transplantation in hernia operations - - - - - - 510
Reflex, "pleural," in artificial pneumothorax - - - - - - 230
— — in lung injuries - - - 242
Renal hæmaturia, conservative treatment in - - - - - 573
— — insufficient indication for nephrectomy - - - - - - 223
— — symptomless - - - - - 573
— — — causes of - - - - - 4
— hæmophilia - - - - - - 573
— hæmorrhage in nephrotomy, control of - - - - - - - 573
— varix and hyperæmia as causes of symptomless renal hæmaturia - 4
— veins, torsion of, causing hæmaturia 5
— — pressure on, causing hæmaturia 5
Repair of bone, cases illustrating - 376
Resection of humerus for chondrosarcoma, autoplastic graft of fibula into humerus - - 49, 383
— of the tongue, marginal, Butlin's operation - - - - - - 42
Respiration, mechanism of - - - 587
Respiratory paralysis, cause of massive collapse of lung - - - 588
Rest, absolute, in lung injuries - - 243
— physiological, in affections of colon 510
— prolonged, for injured ligaments - 87
Retractor, abdominal, semi-automatic - 730
Review of current theories of surgical shock - - - - - - - 114
— of factors involved in operations on the hypophysis cerebri - - 193
— of present position of surgical treatment of exophthalmic goitre - 699
Reviews and Notices of Books:—
The biology of the blood-cells, with a glossary of hæmatological terms (Gruner) - - - - - - 731
The catarrhal and suppurative diseases of the accessory sinuses of the nose (Skillern) - - - - 339
Clinical surgical diagnosis for students and general practitioners (de Quervain) - - - - - 732
International clinics, vol. iii - - 731
Diseases of the ear (Kerrison) - - 545

PAGE

Reviews and Notices of Books, contd.—
Diseases and injuries of the eye, (Sym) - - - - - - - 152
On diseases of the rectum and anus (Harrison Cripps) - - - - 544
Disturbances of the visual function (Lohmann, trans. Macnab) - 547
Fibroids of the uterus, their pathology, diagnosis and treatment (Bland-Sutton) - - - - 338
Genito-urinary diagnosis and therapy (Portner, trans. Lewis) - - 544
International clinics, 4 vols. - - 545
Manual of operative surgery (Binnie) 542
Medical and surgical reports of the Episcopal Hospital, Philadelphia 731
An operating theatre in private practice (Whiteford) - - - - 152
Practical pathology, including morbid anatomy and post-mortem technique (Miller) - - - - 731
Surgery and diseases of the mouth and jaws (Blair) - - - - 546
The surgery of the stomach (Paterson) 150
Surgery of the vascular system (Bernheim) - - - - - - 546
Surgical operations with local anæsthesia (Hertzler) - - - - - 547
A text book of midwifery; for students and practitioners (Johnstone) - 152
A text-book of surgery for dental students (Mills and Humphreys) 340
Rheumatoid arthritis, causing fracture of spine of tibia - - - - 71
Rhizotomy for gastric crises in tabes dorsalis - - - - - - 512
Rib mobilization (Pfeiler Resektion) in chronic empyema - - - - 240
— — in phthisis - - - - - 252
RICHARDS, OWEN: Splenectomy in Egyptian splenomegaly - - 419
ROUQUETTE, STEWART: Recurrent intussusception - - - - - 722
Route to the gall-bladder and biliary passages, an improved - - 200
Rupture of the crucial ligaments of the knee, and fractures of the spine of the tibia - - - - - 70
— of spleen - - - - - - - 159
Ruptured ligaments, necessity of prolonged rest - - - - - 87

SAFETY of intratracheal anæsthesia 95
Saliva, septic, cause of ether bronchitis - - - - - 94
Sarcoma of chest wall - - - - - 505
— of femur cured by Coley's serum - 504
— mistaken for abscess - - - 533
— — innocent tumour - - - 529
— myeloid, of tibia - - - - - 387
— of nose - - - - - - - 207
— simulated by axillary abscess - - 532
— — by frontal mucocele - - - 718
— of stomach - - - - - - 508

PAGE

Scapula, congenital elevation of, cause of 553
— — — prognosis and treatment - 570
— — — series of cases and description of dissected specimen - - 553
— elevation of, importance of differentiating between acquired and congenital - - - - 553, 570
Schmorl's groove and apical tuberculosis 67
Sellar decompression, case of - - 183
— — secondary sepsis in - - - 191
Sensory aphasia, traumatic - - 581
Sepsis, secondary, in sellar decompression - - - - - - 191
Septic saliva, cause of ether bronchitis 94
Severe unilateral hæmaturia without evident cause - - - - - 573
SHERREN, JAMES: Relation of appendicitis to "dyspepsia" and diseases of stomach and duodenum 390
Shock, death from, after resection for gastro-colic fistula - - - 327
— hypodermic injection in - - - 122
— in surgery of lung, to abolish - - 256
— surgical, CO_2 content of the blood in 126
— — the nature of, a critical review - 114
— theories of, Boise - - - - - 121
— — Crile-Mummery - - - 114
— — Meltzer - - - - - 121
— — nerve-cell change - - - 122
— — oligæmia - - - - - - 122
— — suprarenal change - - - 122
— — Yandell Henderson - - - 117
SHORT, A. RENDLE: Surgical shock, a critical review - - - - - 114
SHIPWAY, FRANCIS E.: Some recent methods of anæsthesia - - 96
Sigmoid, diverticulitis of - - - 509
SIMPSON, GRAHAM: A case of amastia 336
— — tuberculous disease of the os calcis - - - - - - 535
Sinus, persistence of, after nephrectomy 215
Skin incision, separate knife used for - 690
— verrucose tuberculosis of - 576, 580
Skull, different behaviour of bone grafts in - - - - - - 378
SMITH, S. ALWYN, and JONES, ROBERT: Rupture of the crucial ligaments of knee, and fractures of spine of tibia - - - - - - - 70
Solidification of lung, production of - 246
Spasm, pyloric, a cause of appendicular dyspepsia - - - - - - 397
Specimen, dissected, of congenital bilateral elevation of scapula - 553
Speech, anatomy and physiology of - 277
Spinal caries - - - - - - 521
— surgery, experiences in - - - 512
Spine of tibia, fractures of - - 70
— typhoid - - - - - - - 602
— — importance of early treatment 605, 608
Spleen, abscess of - - - - - 162
— accessory - - - - - - 168
— cysts of - - - - - - - 506
— echinococcus disease of - - 163
— enlarged, due to blood infections - 161

PAGE

Spleen, an enlarged lymph-gland - 169
— gunshot wounds of - - - - 158
— injuries of - - - - - - 158
— leukæmic, splenectomy fatal in 157, 165, 169
— malarial - - - - - - - 162
— — spontaneous rupture of - - 506
— microscopic appearance in splenomegaly - - - - 421, 422
— movable or wandering - - - 160
— rare anomalies of - - - 168, 169
— removed for Egyptian splenomegaly, character of - - 431
— rupture of - - - - - - 159
— surgery of - - - - 157, 506
— syphilitic - - - - - - 163
— tuberculous - - - - - - 163
Splenectomy - - - - - - 167
— after-treatment of - - - - 431
— complications in - - - - 433
— in Egyptian splenomegaly - 419, 428
— end-results of cases of - - - 170
— fatal in leukæmic spleen 157, 165, 169
— hæmorrhage in - - - - 430
— set of symptoms following - - 169
— statistics of - - - - - - 169
Splenomegaly - - - - - - 165
— Egyptian, diagnosis of - - - 427
— — character of spleens removed for 431
— — particulars of 24 cases - - 432
— — splenectomy in - - 419, 428
— — microscopic appearance of spleen in - - - - 421, 422
Stasis, intestinal, cause of persistent (appendicular) dyspepsia - 395, 397
Statistics of lung complications in abdominal operations - - - - 599
Stomach, diseases of, relation of appendicitis to - - - - - 390
— operative treatment of cancer of - 508
— sarcoma of - - - - - - 508
Strangulated hernia simulated by acute appendicitis - - - - - 719
Streptotrichosis of lung, stages of - 253
— — surgical treatment - - - 252
Subclavian artery, leaking aneurysm of 725
Superior hæmorrhoidal artery, abdominal ligation of, in excision of rectum - - - - 681, 685
Surgery, abdominal, hedonal anæsthesia in - - - - - - 100
— American, during the last twelve months - - - - - - 502
— intracranial, hedonal anæsthesia in 101
— of the lung and pleura, recent advances in - - - - - 228
— major, nitrous oxide-oxygen anæsthesia in - - - - - - 108
— of the spleen - - - - - - 157
— thoracic, intratracheal anæsthesia in 90, 103
Surgical Clinics at Home and Abroad:—
Professor Garré at Bonn - - 695
Professor Sir Wm. Macewen at the University Clinic, Glasgow - 128

PAGE
Surgical Clinics at Home and Abroad, contd.
Sir Victor Horsley at the National Hospital for the Paralyzed - 515
Dr. Lambotte at Antwerp - - 317
Sir Arbuthnot Lane at Guy's Hospital - - - - - - 314
Professor Rutherford Morison at Newcastle-upon-Tyne - - 686
Surgical work at Berck-Plage - 518
Professor Tuffier at the Hospital Beaujon, Paris - - - - - 133
Surgical shock, CO_2 content of the blood in - - - - - 126
— — the nature of, a critical review - 114
— treatment of exophthalmic goitre - 699
Suture of heart - - - - - - 510
Symptomless renal hæmaturia - - 573
— — — causes of - - - - - 4
Syndactylism - - - - - - 143
Synostosis, congenital radio-ulnar (*see* Congenital radio-ulnar synostosis)
Syphilis as a contra-indication in operations on tongue - - - 47
— of lung, surgical treatment - - 252
— of spleen - - - - - - 163

TABES dorsalis, rhizotomy for gastric crises in - - - - - 512
Tait, Lawson, first successful cholecystotomy - - - - - 23
Tetanus, mortality in - - - - - 502
— rational treatment of - - - 502
Thiersch grafts, thickening due to amidoazotoluol - - - - 513
Thoracic and abdominal injuries combined, treatment of - - - 243
— surgery, intratracheal anæsthesia in - - - - - - 90, 103
Thoracoplasty in bronchiectasis - - 248
Thorax, anæsthesia in operations on - 239
THORBURN, WILLIAM: A case of sellar decompression - - - - 183
Thymectomy, cases of - - - - 512
Thymus, rôle of, in Graves's disease - 705
Thyreotoxicosis - - - - - - 700
Thyroid arteries, ligation of, for exophthalmic goitre - - - - 704
— operations, intratracheal anæsthesia in 94
— partial extirpation of - - - 703
— surgery of - - - - - 513
— tumour of clavicle - - - - 401
Thyroidectomy, particulars of twenty-four cases of - - - - - 712
Tibia of cat suitable for experiments on bone-fracture - - - - 440
— graft of, for tuberculosis - - 378
— grafted on ulna for endothelioma - 434
— myeloid sarcoma of - - - - 387
— spine of, liability to fracture in rheumatoid arthritis - - - 71
— — avulsion of - - - - - 73
— — fracture of external tubercle of 81
— — and tuberosity, combined fracture of - - - - - - 84

PAGE
Tongue, anæsthesia in marginal resection of - - - - - - - 45
— marginal resection of, Butlin's operation - - - - - - - 42
— and mouth, malignant disease of - 507
— syphilis in connection with operations on - - - - - - - 47
Transplantation of fibula, late results of 610
— of rectus in hernia operations - 510
Transplanted bone, growth and development of - - - - - 610, 619
Traumatic aneurysms - - - - - 724
— Erb's paralysis, operative intervention in - - - - - - 512
— sensory aphasia - - - - - 581
Trough for evacuating intestine - - 541
Tubal pregnancy, ruptured, mistaken for duodenal ulcer - - - 528
Tubercle, external, of tibial spine, fracture of - - - - - 81
Tuberculosis (*see also* Phthisis)
— apical, influence of the first costal cartilage on - - - - - 55
— auto-inoculation resulting from artificial pneumothorax for - 231
— extirpation of lung in - - - 252
— of kidney, nephrectomy for - - 213
— lung, division of first costal cartilage for - - - - - 57, 252
— — nitrogen displacement for - 229
— — rib mobilization ("Pfeiler resektion") in - - - - - 252
— — surgical treatment - - 229, 250
— of spleen - - - - - - 163
— surgical, treatment at Berck-Plage 518
— of tibia, grafting for - - - 378
— verrucosa cutis - - - 576, 580
Tuberculous abscess of bone - - 525
— disease of os calcis - - - 535
— glands - - - - - - - 526
— joint disease - - - - 523, 525
Tuberosity of tibia, fracture of - - 84
TUFFIER, PROFESSOR; Clinic at the Hospital Beaujon, Paris - - 133
Tumours, importance of taking sections of entire growth- - - - - 532
— kidney, nephrectomy for - - 220
— of lung and pleura, primary malignant - - - - - - 253
TURNER, G. GREY: Two cases of injury to the pancreas - - - - 637
Typhoid spine - - - - - - 602
— — importance of early treatment 605, 608

ULCER, duodenal, simulated by ruptured tubal pregnancy - - 528
— duodenal, excision of - - - 509
— gastric and duodenal, association with appendicular disease - - 397
— jejunal or gastro-jejunal, gastro-jejunostomy for - - - 671
Ulceration of nose, obscure case of (probably tuberculosis verrucosa cutis), simulating epithelioma - 576

PAGE

Ulna, endothelioma of - - - 434
Unilateral hæmaturia, severe, without evident cause - - - - 573
Unreliability of microscopic evidence in malignant disease - - 580
Urinary fistula, nephrectomy for - - 222
Urine, value of ascertaining, sp. gr. of in nephrectomy - - 212

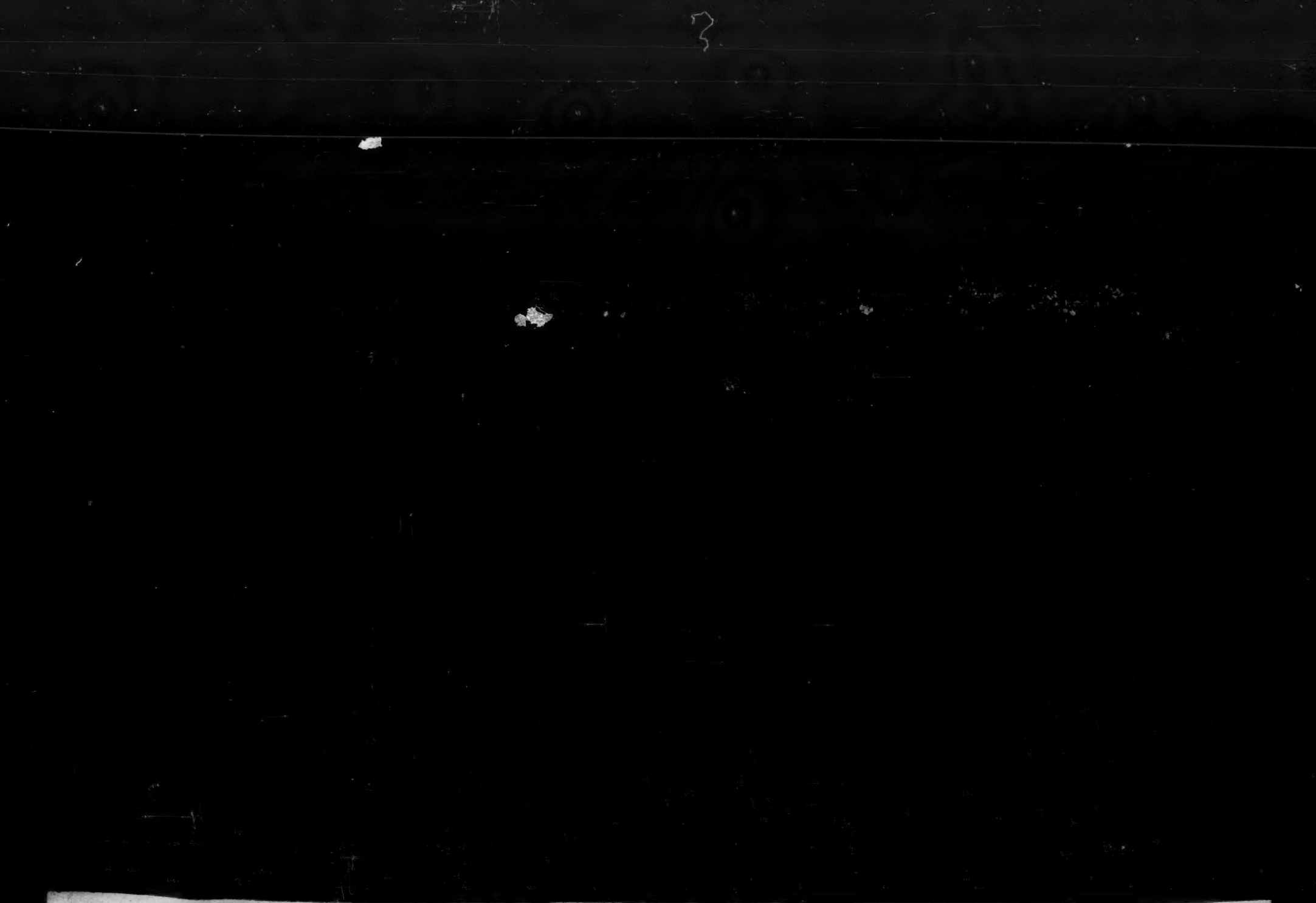
VAGUS, injection into, to abolish shock in surgery of lungs - - 256
— tumour of, removed in mistake for fibroma - - - - - - 329
Vater's papilla, carcinoma of - - 508
Vermiform appendix, intussusception of, in adult - - - - - 673, 721
— — — with protrusion through anus 721
Verrucose tuberculosis of skin - 576, 580
Vesical calculus, radiography in - - 414
— — symptoms and signs - - - 413
Volvulus of the cæcum, causing acute obstruction - - - - - 644
— saccule of bladder mistaken for - 323
Vomiting, absence of, in intratracheal anæsthesia - - - - 94, 104

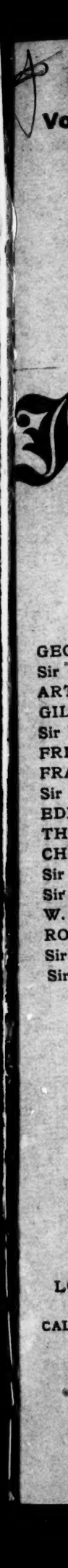
PAGE

WANDERING spleen - - - - 160
WILKIE, D. P. D.: Congenital radio-ulnar synostosis - - 366
WHITELOCKE, R. H. ANGLIN: Loose bodies in the knee, and their etiology and growth - - - - 650
WILLAN, R. J.: Litholopaxy, its evolution, indications and contra-indications, with cases - - 406
WILLIAMS, IDWAL J., and MONSARRAT, K. W.: Intramural extension in rectal cancer - - - - - 173
WILLIAMSON, GEORGE SCOTT: Endothelioma of ulna replaced by a tibial bone-graft - - - 434
WILSON, W. and M'CONNELL, R. J.: Intussusception of the vermiform appendix - - - - - - 673
Wound-fever, aseptic, and post-operative hyperthyroidism - 513

X-RAYS, value in pulmonary surgery - - - - - - - - 228

JOHN WRIGHT AND SONS LTD., PRINTERS AND PUBLISHERS, BRISTOL.





Medical Lib.

Vol. I.] *Issued Quarterly. Single Numbers, 7/6 net.* [No. 4.
Subscription 25/- net, per annum, post free in the United Kingdom; postage 1/6 extra to Subscribers Residing Abroad.

GENERAL LIBRARY
APR 19 1915
UNIV. OF MICH.

The British Journal of Surgery

UNDER THE DIRECTION OF THE FOLLOWING EDITORIAL COMMITTEE:

Sir BERKELEY G. A. MOYNIHAN (Leeds), *Chairman.*

GEORGE E. ARMSTRONG (Montreal)
Sir CHARLES B. BALL, Bart. (Dublin)
ARTHUR E. J. BARKER (London)
GILBERT BARLING (Birmingham)
Sir WILLIAM BENNETT, K.C.V.O. (London)
FREDERIC F. BURGHARD (London)
FRANCIS M. CAIRD (Edinburgh)
Sir W. WATSON CHEYNE, Bart., C.B. (London)
EDRED M. CORNER (London)
THOS. CRISP ENGLISH (London)
CHARLES H. FAGGE (London)
Sir RICKMAN J. GODLEE, Bart., K.C.V.O. (London)
Sir A. PEARCE GOULD, K.C.V.O. (London)
W. SAMPSON HANDLEY (London)
ROBERT JONES (Liverpool)
Sir WILLIAM ARBUTHNOT LANE, Bart. (London)
Sir ALEXANDER MacCORMICK (Sydney)
GEO. H. MAKINS, C.B. (London)
HENRY A. MOFFAT (Capetown)
Sir HENRY MORRIS, Bart. (London)
A. W. MAYO-ROBSON, C.V.O. (London)
RUTHERFORD MORISON (Newcastle-on-Tyne)
Sir THOMAS MYLES (Dublin)
R. H. PARRY (Glasgow)
D'ARCY POWER (London)
SIDNEY W. F. RICHARDSON (Capetown)
THOMAS SINCLAIR (Belfast)
Lt.-Col. CECIL R. STEVENS (Calcutta)
HAROLD J. STILES (Edinburgh)
EDWARD H. TAYLOR (Dublin)
J. LYNN THOMAS, C.B. (Cardiff)
HENRY ALEXIS THOMSON (Edinburgh)
WILLIAM THORBURN (Manchester)

E. W. HEY GROVES (Bristol), *Editorial Secretary.*

APRIL, 1914

BRISTOL: JOHN WRIGHT & SONS LTD.
LONDON: STATIONERS' HALL COURT. SIMPKIN, MARSHALL, HAMILTON, KENT & CO. LTD.
TORONTO: THE MACMILLAN CO. OF CANADA LTD.
CALCUTTA: BUTTERWORTH & CO. (INDIA) LTD.: THACKER, SPINK, & CO. BOMBAY: THACKER & CO. LTD
MELBOURNE, SYDNEY, ADELAIDE, and BRISBANE: G. ROBERTSON & CO. PROPRIETARY LTD.
SYDNEY: ANGUS & ROBERTSON LTD. NEW ZEALAND: WHITCOMBE & TOMBS LTD.
UNITED STATES OF AMERICA: WILLIAM WOOD & CO., NEW YORK, *Sole Agents.*

CONTENTS

	PAGE
John Abernethy (with Portrait)	549
Congenital Elevation of the Scapula: A Series of Eighteen Cases, with a detailed description of a Dissected Specimen — H. A. T. FAIRBANK	553
Severe Unilateral Hæmaturia without Evident Cause — GILBERT BARLING	573
Obscure Case of Ulceration of the Nose in a Child, simulating an Epithelioma — DAVID NABARRO AND T. T. HIGGINS	576
Traumatic Sensory Aphasia — V. ZACHARY COPE	581
Massive Collapse of the Lung — W. PASTEUR	587
Typhoid Spine: Report of Two Cases and Short Review of the Subject — S. J. ELKIN AND JASPER HALPENNY	602
Late Results of Three Cases of Transplantation of the Fibula: With Remarks on the process of Growth and Physiological Development of Transplanted Bone — C. J. BOND	610
Radical Operation for Chronic Osteomyelitis — SETON PRINGLE	625
Excision of Diaphysis of Humerus, with full Functional Recovery — ARTHUR J. EVANS	632
Two Cases of Injury to the Pancreas — G. GREY TURNER	637
Intestinal Obstruction due to Rare Causes — JOHN MARNOCH	644
Loose Bodies in the Knee: With Special Reference to their Etiology and Growth — R. H. ANGLIN WHITELOCKE	650
Two Cases of Complete Division of Duodenum at the Duodeno-jejunal Junction, treated by Closure of the Divided Ends and Gastro-jejunostomy — H. COLLINSON AND L. R. BRAITHWAITE	665
Case of Intussusception of Vermiform Appendix — R. J. M'CONNELL AND W. WILSON	673
Arterial Supply of Rectum and Pelvic Colon — HAMILTON DRUMMOND	677
Visits to Surgical Clinics at Home and Abroad:	
Professor Rutherford Morison at Newcastle-upon-Tyne	686
Visit to Prof. Garré's Clinic at Bonn	695
Review of the Present Position of Surgical Treatment of Exophthalmic Goitre — JAMES BERRY	699
Instructive Mistakes	718
Short Notes of Rare or Obscure Cases	721
New Instruments and Appliances	730
Reviews and Notices of Books	731
Title-page, Contents, and General Index to Vol. I.	

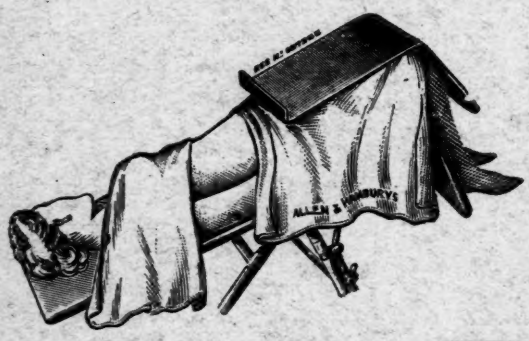
ALLEN & HANBURYS, Ltd.

SURGICAL INSTRUMENT MAKERS.

A. & H.s' SPECIAL DESIGNS.

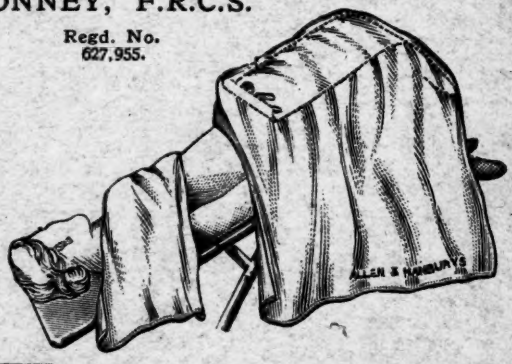
INSTRUMENT TRAY

as designed by VICTOR BONNEY, F.R.C.S.



PRICE **15/6** EACH.

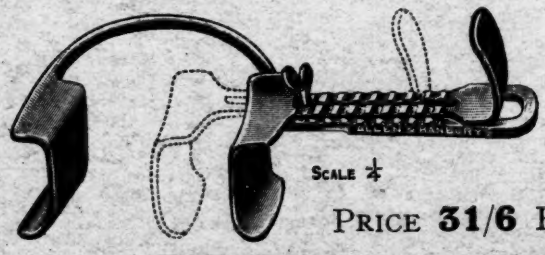
Regd. No. 627,955.



A SEMI-AUTOMATIC ABDOMINAL RETRACTOR.

Designed by JOHN EVERIDGE, F.R.C.S.

As described in the *Lancet*, Feb. 28th, 1913.



SCALE ½

PRICE **31/6** EACH.

48, Wigmore Street, LONDON, W.

Works—BETHNAL GREEN, E.

Telephones: Mayfair 6476 (four lines). Telegrams: "Orthopedic, Wesdo, London." Codes: Lieber's A.B.C. 5th Edition.

EDITORIAL NOTICES.

SPECIAL NOTICE.—Handsome and strong Cloth Cases for Vol. I, with bevelled boards, are now ready, together with instructions for binding. Price **1/6** post free; or the Publishers will case the volume for those who so desire for **3/-** post free on receipt of the four numbers.

TO CONTRIBUTORS.

EDITORIAL COMMUNICATIONS should be addressed to *The Editorial Secretary, British Journal of Surgery, Stonebridge, Bristol*; Original articles may be forwarded, if desired, to any other member of the Committee, and these are accepted with the understanding that they are contributed to this Journal only.

Each contributor of a paper is entitled to 25 free copies of the Journal on application, and may have special reprints by arrangement with the Publishers if notice is given when the proofs are returned.

TO SUBSCRIBERS AND OTHERS.

The SUBSCRIPTION price is **25/-** per year, or **7/6** for a single quarterly number, post free in Great Britain. Foreign postage 1/6 per year extra. Bound Volume complete for **30/-** net.

BUSINESS COMMUNICATIONS should be addressed JOHN WRIGHT & SONS LTD., BRITISH JOURNAL OF SURGERY, BRISTOL. Remittances may be made payable to *The British Journal of Surgery.*

The Sole Agents for the United States of America are WILLIAM WOOD & CO., 51 Fifth Avenue, New York, to whom subscriptions should be sent.

LUKENS Sterile Catgut

Trade ("Bartlett Process") Mark.

Has been subjected to many exhaustive tests which invariably proved it to be absolutely RELIABLE.

WRITE FOR FREE SAMPLE AND CATALOGUE.

STOCKED BY ALL HIGH CLASS DISTRIBUTING HOUSES **10/-** PER DOZ.

We are very frequently in receipt of communications from surgeons conducting many of the largest clinics in this and foreign countries, reporting series of consecutive clean cases, ranging from hundreds up into the thousands, **without a single case** attributable to catgut infection.

FULLY GUARANTEED AGAINST DETERIORATION!

Wholesale Agent—

JOSEPH DAVIS, 13 Poland Street, London, W.

JOHN BALE, SONS & DANIELSSON LTD.

Clinical Surgical Diagnosis for Students and Practitioners

By **Prof. F. de QUERVAIN,** Director of the Surgical Clinic, University of Basle. Translated by J. SNOWMAN, M.D. Nearly 800 pp., with 510 illustrations and 4 coloured plates. Royal 8vo. Price **25s.** net. Postage: Inland 7d., Abroad 2/-.

The British Medical Journal says:
"We do not know of any better book of its kind."
"We have never yet seen such a uniformly beautiful collection of pictures of surgical conditions."
A book which we think might well be in the hands, not only of practitioners of medicine in general, but also in those of teachers of surgery."

Surgery of the Lung

By **C. GARRE,** Professor of Surgery at the University of Bonn. and **H. QUINCKE,** formerly Professor of Medicine at the University of Kiel. Translated by DAVID M. BARCROFT, M.D. With 114 Coloured and other illustrations, and two coloured plates. Royal 8vo, about 270 pp. Price **12s. 6d.** net, postage 4d.

Orthopædics in Medical Practice

By **Prof. ADOLF LORENZ** and **Dr. ALFRED SAXL.** Translated by L. C. PEEL RITCHIE, M.D. Demy 8vo. Price **7s. 6d.** net, postage 4d.

A Handbook on Surgery, intended for Dental and Junior Medical Students.

By **ARTHUR S. UNDERWOOD, M.R.C.S., L.D.S.,** Late Examiner, Royal College of Surgeons of England, and **BAYFORD UNDERWOOD, L.R.C.P.** Price **3s. 6d.** net, postage 3d.

Disturbances of the Visual Functions

By **Prof. W. LOHMANN,** Chief Physician to University Eye Clinic, Munich. Translated by ANGUS MACNAB, M.B. Royal 8vo, Price **15s.** net. postage 3d.

The Internal Secretory Organs: THEIR PHYSIOLOGY AND PATHOLOGY.

By **Prof. Dr. ARTUR BIEDL,** Vienna. With an Introductory Preface by LEONARD WILLIAMS, M.D. Royal 8vo. Price **21s.** net, postage 6d.

Epidemic Infantile Paralysis (HEINE-MEDIN DISEASE).

By **Prof. PAUL H. RÖMER.** Translated by H. RIDLEY PRENTICE, M.D. Royal 8vo. Price **7s. 6d.** net, postage 5d.

83, 85, 87, 89, 91, GREAT TITCHFIELD ST., LONDON, W.

NOW READY. **Price 21/- net.**

1230 *pages, 8 coloured plates and 523 other illustrations*

THE PRACTICE OF SURGERY

BY

RUSSELL HOWARD,

M.B., M.S. (Lond.), F.R.C.S. (Eng.),

Surgeon to the Poplar Hospital; Assistant Surgeon, London Hospital; Joint Lecturer on Surgery and Teacher of Operative Surgery, London Hospital Medical College.

Author of "Surgical Nursing," "The House-Surgeon's Vade-Mecum," etc.

Please write for prospectus.—

EDWARD ARNOLD,

LONDON: 41 and 43, Maddox Street, W.

E. & S. LIVINGSTONE.

FELLOWSHIP EXAMINATION PAPERS.

Set by the ROYAL COLLEGE OF SURGEONS, EDINBURGH, 1906–1913. **1/-** net, postage 2d.

Fourth Edition. Crown 8vo, Cloth, pp. 288 + xxvi. With fine Coloured Illustrations. **5/6** *net. Inland postage* **4d.**

ANATOMY OF THE BRAIN AND SPINAL CORD.

By J. RYLAND WHITAKER, B.A., M.B.Lond., F.R.C.P.Ed. Lecturer on Anatomy, School of Medicine, Edinburgh.

Just Published. Crown 8vo, Cloth, 110 pp. Illustrated. Price **2/-** *net. Inland postage* **3d.**

MODERN WOUND TREATMENT, and the Conduct of an Operation.

By Sir GEORGE T. BEATSON, K.C.B., B.A.Camb., M.D.Edin., Surgeon to the Western Infirmary and Cancer Hospital, Glasgow.

Demy 8vo, Cloth, 109 pp. Price **2/6** *net. Inland Postage,* **4d.**

THE CONSERVATIVE TREATMENT OF TUBERCULAR JOINT DISEASE AND COLD ABSCESS.

By Dr. A. HENLE, Preface by **Professor J. Von Mikulicz,** LL.D., Edin. Trans. from German by **CHAS. W. CATHCART** F.R.C.S., Surgeon Royal Infirmary, Edinburgh.

CATECHISM SERIES. 1/- per Part.

Now Ready. Crown 8vo, Cloth, 372 pp. Price **4/6** *net. Inland postage,* **4d.**

SURGERY (5 parts), Complete in One Volume.

Also Ready.

OPERATIVE SURGERY, Part I **1/-** per part. Part II in the Press

SURGICAL ANATOMY (2 parts). 1/- per part.

Crown 8vo, Cloth, 2 vols., 1,064 pp., 266 Illustrations. Price **10/-** *net. Inland Postage,* **6d.**

APPLIED ANATOMY: Surgical, Medical, and Operative.

By A. A. SCOTT SKIRVING, C.M.G., F.R.C.S.Ed., Assistant Surgeon, Royal Infirmary, Edinburgh; Surgeon, Leith Hospital.

In the Press. New Edition. Greatly Enlarged. Price **7/6** *net.*

A MANUAL OF SURGICAL ANATOMY.

By CHARLES R. WHITTAKER, F.R.C.S.Ed., Senior Demonstrator of Anatomy, Surgeons' Hall, Edinburgh.

15, 16, and 17, TEVIOT PLACE, EDINBURGH.

H. K. LEWIS'S PUBLICATIONS.

JUST PUBLISHED. FIFTH EDITION. Revised and Enlarged. With 8 Plates and 84 Text Illustrations. Demy 8vo. Price **10s. 6d.** net; post free, **10s. 11d.**, abroad, **11s. 4d.**

ANÆSTHETICS: Their Uses and Administration.

By **DUDLEY W. BUXTON, M.D., B.S., M.R.C.P.,** Administrator of Anæsthetics and Lecturer in University College Hospital; Consulting Anæsthetist to the National Hospital for Paralysis and Epilepsy, Queen Square; Senior Anæsthetist and Lecturer on Anæsthetics in the Royal Dental Hospital of London.

NOW READY. SIXTH EDITION. Rewritten. In One Volume. With 1438 Illustrations. Royal 8vo. **30s.** net; inland postage, **7d.**

MANUAL OF OPERATIVE SURGERY.

By **J. FAIRBAIRN BINNIE, A.M., C.M.Aberd.,** Surgeon to the General Hospital, Kansas City; Fellow of the American Surgical Association, &c.

"Binnie's Operative Surgery is a work of the highest excellence, and is of the greatest utility to the operating surgeon."—*Practitioner.*

*** *Complete CATALOGUE of H. K. LEWIS'S PUBLICATIONS sent post free on application.*

London: H. K. LEWIS, 136, Gower Street, & 24, Gower Place, W.C. *Telegrams: "Publicavit, Euroad, London." Telephone: Central 10721.*

HOLLAND'S INSTEP SUPPORT

"Most valuable for Flat Foot."—*B.M.J.*

6/6 per pair, Gent's 7/6.

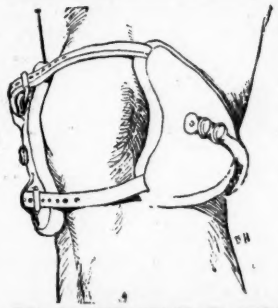
ENTIRELY BRITISH MADE.

A pencil tracing of the foot is the best guide for size.

Supports of varying grades sent on approval.

T. HOLLAND, 46, S. Audley Street, W.

KNEE TRUSSES



for **Dislocated Internal** or **External Semilunar Cartilages,** for Chronic **Dislocations of the Patella,** and relaxed internal or lateral ligaments. The best results are obtained by *fitting* the side plates to the patient's knee, but if this be impracticable, send circumference of joint over patella only with knee semi-flexed. State which knee, and short description of the case.

*** Used by professional footballers, tennis players, etc. The truss *does not interfere* with the *free action of the knee* on flexion or extension. **Price £2 2s.**

HAWKSLEY & SONS
357, OXFORD STREET, LONDON, W.
Telephone—1182 Mayfair.

BAILEY'S SURGICAL INSTRUMENTS.

CATALOGUE POST FREE. OVER 1,100 ILLUSTRATIONS.

EAR, NOSE, AND THROAT SET.

Containing—

	s.	d.
1 Aural Spring Forceps ..	2	6
1 Michel's Rhinoscope ..	8	6
1 Hartmann's Aseptic Nasal Forceps ..	3	6
1 Hartmann's Aseptic Aural Forceps ..	3	3
1 Gardner Browne's Tuning Fork	5	0
1 3-oz. All Metal Aseptic Ear Syringe, with 2 Nozzles	10	6
1 Aseptic Frankel Tongue Depressor	2	6
1 Set 6 Laryngeal Mirrors (each 1/-)	6	0
1 Universal Handle for ditto	1	3

Containing—

	s.	d.
3 Woake's Eustachian Catheters, Electro Plated (each 2/6) ..	7	6
1 Plug Mount to connect do. to Politzer Bag ..	1	0
1 Jobson Horne's Head Mirror, with Aluminium Fittings	12	6
1 Set 3 Toynbee's Aural Speculums, Electro Plated	6	0
1 Thudicum's (Golden Square Pattern) Nasal Speculum, N.P. ..	2	0
1 Bronner's Aluminium Aural Probe	1	0
1 Hartmann's Nasal Probe	1	6

N.S. 5716.

COMPLETE SET, in Leather Case (measures 11 × 7½ × 2 in.), with Washable Lining, with Lock and Key and Handle (as Fig.) **£4 0 0**

W. H. BAILEY & SON, Surgical Instruments, Hospital Furniture, **38, OXFORD STREET, 2, RATHBONE PLACE, LONDON.**

Telegrams—"BAYLEAF, LONDON." Telephone—2942 GERRARD.

33, MUSEUM STREET,
LONDON, W.C.

Dear Sir,

Our ARTIFICIAL LIMBS have now a world-wide reputation for comfort, lightness and durability; advise your patients to come to us and so be sure that no time or effort will be spared to make the case a success. 19 Gold and Silver Medals awarded.

Yours faithfully,
J. & E. FERRIS.

Milne's Dressings and Ligatures

Introduced to Surgeons over **thirty years ago** under the late Lord Lister's personal supervision. Used **to-day** by all the leading Surgeons because of their excellent quality and reasonable price.

NEW CATALOGUE (issued in October) ON APPLICATION.

The Galen Manufacturing Company Limited,

WILSON STREET, NEW CROSS, LONDON, S.E.

KIMPTON'S PUBLICATIONS

ASHHURST.—An Anatomical and Surgical Study of Fractures of the lower end of the Humerus. By A. P. Cooper Ashhurst, M.D. Large 8vo. Illus. Cloth Price **14s.** net

BERG.—Surgical Diagnosis. By Albert A. Berg, M.D. Small 8vo. 543 pp. Illus. Cloth. Price **16s.** net

BLAIR.—Surgery and Diseases of the Mouth and Jaws. By Vilray Papin Blair, M.D. 2nd Ed. Ry. 8vo. 664 pp. 384 Illus. Price **24s** net

HIRSCHMAN.—Handbook of Diseases of the Rectum. By L. J. Hirschman. 2nd Ed. Ry. 8vo. 339 pp. 172 Illus. 4 plates Price **18s.** net

MARTIN.—Surgical Diagnosis. By Edward Martin, M.D. Royal 8vo. 772 pp. Illus. Cloth. Price **28s.** net

OCHSNER & THOMPSON.—Surgery and Pathology of the Thyroid and Parathyroid Glands. Ry. 8vo. 391 pp. 57 Illus. 40 plates. Price **25s.** net

PARK.—Principles and Practice of Modern Surgery. By Roswell Park, M.D., LL.D. 2 Vols. Imp 8vo. 1074 pp. 722 Illus. 60 plates. Price **36s.** net

PORTNER.—Genito-Urinary Diagnosis and Therapy. By Dr. Ernst Portner. Translated by B. Lewis, M.D. Ry. 8vo. 235 pp. Illus. **10s. 6d.** net

WHITMAN.—Treatise on Orthopædic Surgery. By Royal Whitman, M.D., M.R.C.S. 3rd Ed. Ry. 8vo. 871 pp. 554 Illus. Cloth. Price **28s.** net

WOOLSEY.—Applied Surgical Anatomy. By G. Woolsey, M.D. 2nd Ed. Ry. 8vo. Illus. **21s.** net

COMPLETE CATALOGUE POST FREE ON APPLICATION.

HENRY KIMPTON, Publisher & Bookseller.
263, HIGH HOLBORN, LONDON, W.C., ENG.

BOOKS

For the Medical Profession also for all Examinations

Special Departments for Medical, Law, Educational, and Scientific Works, etc., etc.

SECOND-HAND at HALF PRICES
New at 25 per cent. Discount.

Send for **CATALOGUE No. 61**, free, and state wants

Books Sent on Approval.

BOOKS BOUGHT. BEST PRICES GIVEN.

W. & G. FOYLE, 121-123, Charing Cross Road, — LONDON, W.C. —
Telegrams: "Foylibra, London."

SURGICAL INSTRUMENTS.

KUHN STERILE CATGUT

SCHAERER, BERNE.

41 Berners Street, LONDON, W.

WRIGHT, PUBLISHERS, BRISTOL.

Fcp. 8vo. Illus. Frontispiece, Cloth 2/6 *net; Leather* 3/6 *net.*

Lectures on SURGICAL NURSING.

By E. STANMORE BISHOP, F.R.C.S. Eng.

"This little volume hits off almost exactly the proper line to take in telling nurses about the true inwardness of the system they are to be taught to observe. . . . It is to be commended not only to those who are beginning their training, but to those superior persons who know all."—*Brit. Med. Jour.*

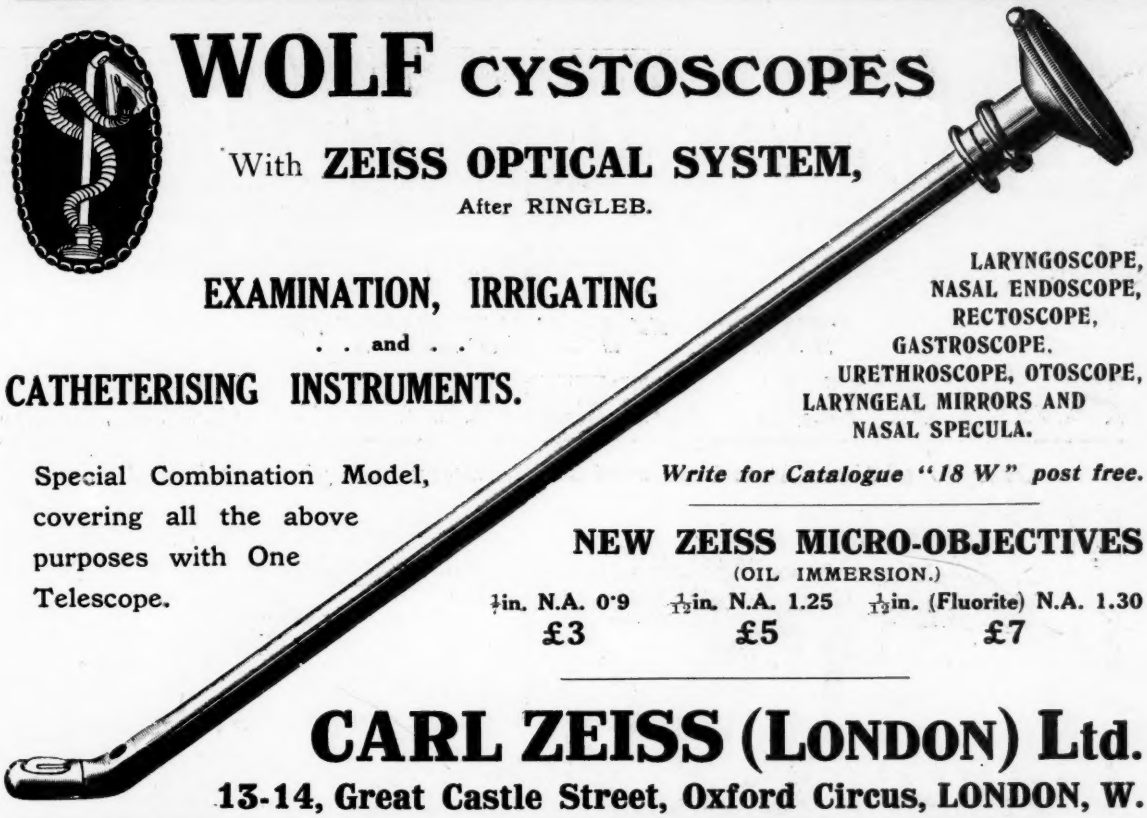
Bristol: JOHN WRIGHT & SONS LTD.

WOLF CYSTOSCOPES

With **ZEISS OPTICAL SYSTEM,**
After RINGLEB.

EXAMINATION, IRRIGATING
. . and . .
CATHETERISING INSTRUMENTS.

Special Combination Model, covering all the above purposes with One Telescope.



LARYNGOSCOPE,
NASAL ENDOSCOPE,
RECTOSCOPE,
GASTROSCOPE.
URETHROSCOPE, OTOSCOPE,
LARYNGEAL MIRRORS AND
NASAL SPECULA.

Write for Catalogue "18 W" post free.

NEW ZEISS MICRO-OBJECTIVES
(OIL IMMERSION.)

⅛in. N.A. 0·9	1/12in. N.A. 1.25	1/12in. (Fluorite) N.A. 1.30
£3	£5	£7

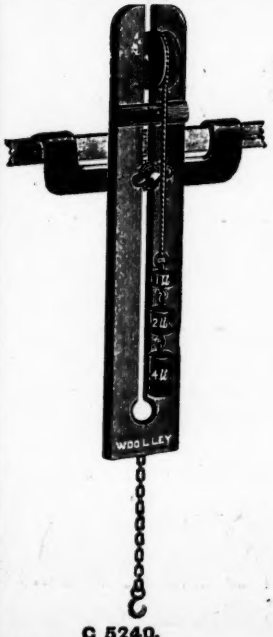
CARL ZEISS (LONDON) Ltd.

13-14, Great Castle Street, Oxford Circus, LONDON, W.

JAMES WOOLLEY SONS & CO. LTD

SURGICAL INSTRUMENTS.

VICTORIA BRIDGE, MANCHESTER.



C 5240.

NEW MODELS OF
EXTENSION APPARATUS

(Woolley's Registered Designs.)

C5238. (Registered Design No. 631478). Made of solid brass. By the improved method of attachment, the vertical pillar may be adjusted to varying heights, and may be set at almost any angle. A linked chain is passed round the foot-rail of the bedstead, which is then drawn through a slot and is firmly held in position by means of a wing nut.

PRICE, complete in wood box ... **10/6**

C5240. (Registered Design No. 627289.) This apparatus can be instantaneously attached to any bed-rail. Height adjusted by one turn of the thumb screw. It is one of the simplest detachable Extension Apparatus ever devised. When not in use, the apparatus may be hooked on to the head of the bed, and is thus always available.

PRICE, complete in box ... **6/6**

C5242. Set of Iron Weights, suitable for either of the Extension Apparatus shown above, consisting of two 1-lb., one 2-lb., and two 4-lb., **5/6** extra, with double hooks, complete in box.

C5238.

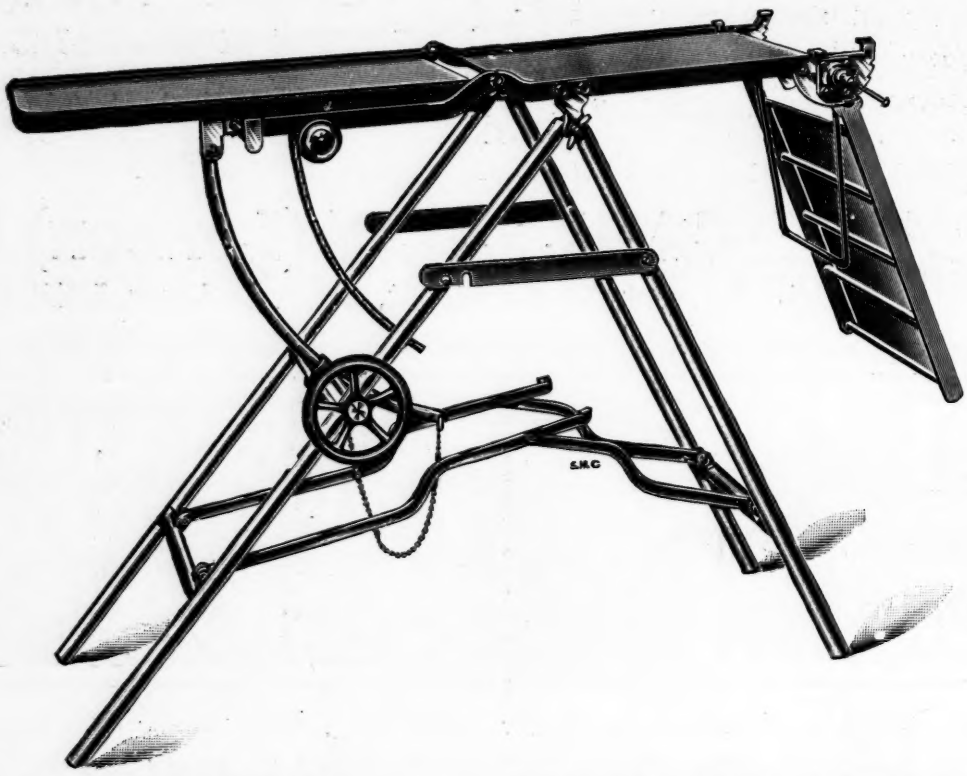
Catalogue on Application.

THE SURGICAL MANUFACTURING COMPANY

Telephone CITY 6677 (3 LINES) (W. J. Edwards) PROPRIETOR Telegrams:- "SURGMAN. LONDON

THE "PERFECT" PORTABLE OPERATING TABLE.

Over 70 of these have been sold and in every case given satisfaction.



Made of Seamless Steel Tubing. **All Aluminium Finished, Welded Joints.**
Strong and Durable. **Light in Weight.**
Adjustable in Height and to every required position. **Very Rigid.**
Takes apart in two pieces, and folds quite flat.

Price ... **£10 : 10 : 0**

A GUARANTEE
TRADE MARK SURGMAN
OF RELIABILITY

CATALOGUE FREE ON APPLICATION.

We are actual makers of Surgical Instruments and Hospital Furniture, having extensive works in London. Repairs to Instruments a Speciality.

85 Mortimer Street London W.

2 Doors from Great Portland St. **OPEN DAY & NIGHT** 3 Minutes from Oxford Circus.

MAYER & MELTZER

——MANUFACTURERS OF——

Surgical Instruments of Highest Quality

— ESTABLISHED OVER FIFTY YEARS. —

DIAGNOSTIC TUNING FORKS.

By

JAMES CANTLIE, M.B., F.R.C.S.

"The Use of the Tuning Fork and Stethoscope in the Estimation of Abdominal and Thoracic Viscera and of certain Pathological Conditions."

See *Jour. of Tropical Medicine*, Jan. 15th, 1914; and *Brit. Med. Jour.*, Feb. 21st, 1914.

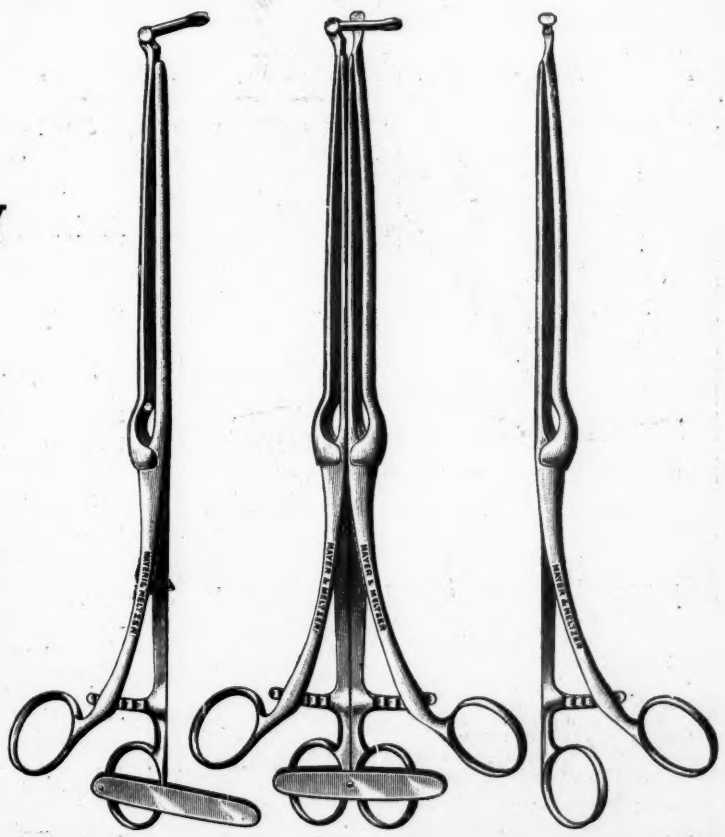
GASTRO-ENTEROSTOMY CLAMPS.

Designed by Mr. BILTON POLLARD, F.R.C.S.

See *Lancet*, Nov. 22nd, 1913.

"The advantage claimed for these clamps is that they can be easily disconnected without sliding one on the other, and consequently without exerting any strain on the stitches uniting the jejunum to the stomach."

Full particulars on application.



MAYER & MELTZER, 71 Great Portland Street, LONDON, W.

Branches:—MELBOURNE, CAPE TOWN, JOHANNESBURG.

THE CAREFUL SURGEON'S "VADE MECUM"

Trade Mark Regd. **"STERILLA"** Brand **LIQUID SURGICAL SOAP**

Used by Leading British Surgeons throughout the World.

ALWAYS HAVE IT HANDY.

"Sterilla" cleanses and sterilizes in one operation. No other antiseptic needed. Does not injure skin or instruments. Non-poisonous, but equal to pure carbolic acid in bactericidal potency (R. W. Coefficient 1).

"Sterilla" Liquid Surgical Soap is issued in bottles (16 oz.) at **2/6**, and small nickelled flasks, as illustrated, at **1/3.** Safe and handy for Bag or Pocket.

Sold by leading Chemists and Instrument Dealers.

Samples and literature free on request from

Harold E. Matthews & Co.,
CLIFTON, BRISTOL.

Indian Depôts { Kemp & Co., Bombay,
F. Bliss & Co., Simla.

Grand Prix awarded 1913.

Gold Medal awarded 1913

MACDONALD'S "GOLD MEDAL" STEAM STERILIZER (Patent Nos. 5581 & 1317)

FOR USE OVER FIRE OR GAS BURNER.

1—Cheap and simple. 2—Efficient for Dressings and Instruments. 3—Dressings made perfectly Dry and Aseptic. 4—The small amount of steam evolved allows its use in any room. Germs are all destroyed in less than half an hour. All that is necessary is to pour in requisite amount of water, place in dressings, adjust lid and set on gas ring, fire, or other heating apparatus.

Full particulars on request. Sterilizers sent out on approval if desired.

Prices: £2 17s. 6d., £4 17s. 6d., £7 10s., £10 10s.

Manufacturers of Surgical Instruments, Hospital Furniture, Dressings, Waterproof Sheetings, Beds, &c.

THE MEDICAL SUPPLY ASSOCIATION
167 to 173, GRAY'S INN ROAD, LONDON ENG.
Also at Edinburgh, Glasgow, Dublin, Sheffield, Cardiff and Belfast.
Telegraphic Address: "Grevillite, London."

Just Published. *Crown 8vo.* **3/6** *net.*

APPENDICITIS:

A Plea for Immediate Operation.

By EDMUND OWEN, F.R.C.S., D.Sc. (Hon.),

Surgeon to the French Hospital; Consulting Surgeon to St. Mary's Hospital, and to the Hospital for Sick Children, Great Ormond Street, London.

The object of this volume is to help in making early operation the routine treatment of appendicitis. The author insists that safety in the treatment of appendicitis can be obtained only by early recognition of the disease and by prompt operation.

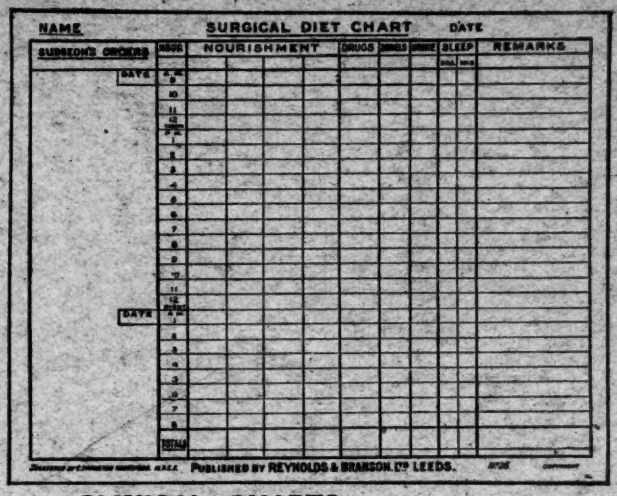
CONTENTS.

I.—Structure and function of the appendix. II.—General remarks. III.—Pathology. IV.—Causation. V.—Diagnosis. VI.—Differential diagnosis. VII.—Appendicitis in children. VIII.—Danger of waiting. IX.—Whilst waiting for operation. X.—Stealthy appendicitis. XI.—Exploration in doubtful cases. XII.—When to operate. XIII.—Fool's paradise stage. XIV.—Operation. XV.—Operation in aseptic cases. XVI.—Operation in septic cases. XVII.—Treatment after operation. XVIII.—After-results of operation. XIX.—Chronic and relapsing appendicitis. XX.—Typhoid appendicitis. XXI.—Appendicitis during pregnancy. XXII.—Dyspepsia and appendicitis. XXIII.—Complications. XXIV.—Statistics. XXV.—Causes of death; unnecessary deaths.

Bristol: JOHN WRIGHT & SONS LTD.

REYNOLDS & BRANSON LTD.

Surgical Diet Chart. LEEDS.


NAME SURGICAL DIET CHART DATE

SURGEON'S ORDERS | HOUR | NOURISHMENT | DRUGS | SLEEP | REMARKS

DAYS

DAYS

PUBLISHED BY REYNOLDS & BRANSON LTD LEEDS.

The annexed engraving shows a surgical diet chart intended for use in conjunction with the combined temperature, pulse, and respiration chart of Mr. Mayo-Robson. Redundant details have been eliminated, and spaces have been left for surgeons' orders and nurses' remarks. On a record of twenty-fours which includes portions of two days there is frequently doubt as to which day the record refers. This has been obviated by having two spaces for dates at the left of the "Hour" column. Under "Nourishment" the sub-headings have been left blank, to be filled in as required, *i.e.*, "Rectal Saline," "Milk," and so forth. All the details have been printed in bold type, easily discernible in the shaded light of a sick-room.

CLINICAL CHARTS.

	Per Doz.	Per 100	Per 1000
Size of Visiting List, R. & B.'s	3d.	2/-	—
Octavo, R. & B.'s	4d.	2/6	21/-
Quarto, R. & B.'s	6d.	3/6	25/-
M. & E.; and 4-Hourly; suggested by A. W. Mayo-Robson, Esq., F.R.C.S.	6d	3/6	25/-
Hospital Chart, suggested by Dr. T. Churton	9d.	5/-	—
Short Interval Chart, suggested by Dr. J. B. Hellier	9d.	5/-	—
Sanatorium Chart, suggested by Dr. J. M. Barbour	6d.	3/6	25/-
Surgical Diet Chart, suggested by C. Hamilton Whiteford, Esq., M.R.C.S.	9d.	5/-	36/-
Urine Chart	9d.	—	—
Weight Chart, suggested by Dr. J. B. Hellier	1/-	7/-	—

Specimens free on application.

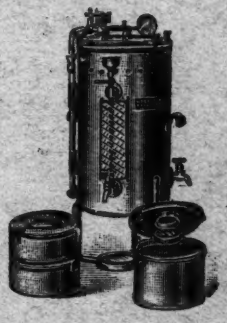
HOSPITALS & GENERAL CONTRACTS Coy, LTD.

SURGICAL INSTRUMENT MAKERS ETC.

OUR HIGH-PRESSURE STERILIZERS

(10 lbs. to sq. inch.)

ARE GUARANTEED TO GIVE PERFECT SATISFACTION TO USERS.



Inside Measurements	Price complete with all fittings. £ s. d.	Set of 3 Drums, illustrated, extra. £ s. d.
No. 2 19 ins. × 10 ins.	11 10 0	2 14 0
No. 3 19 ins. × 12 ins.	13 10 0	3 5 0
No. 4 19 ins. × 13½ ins.	16 0 0	4 2 0

HOSPITALS, NURSING HOMES, Etc.

Completely Equipped.

Estimates Free.

TELEGRAMS: CONTRACTING LONDON. TELEPHONE 5840 GERRARD 2 LINES

25-35 MORTIMER STREET, LONDON, W.

DOWN BROS.' SPECIALITIES.

— AN —

Improved PORTABLE APPARATUS

FOR THE

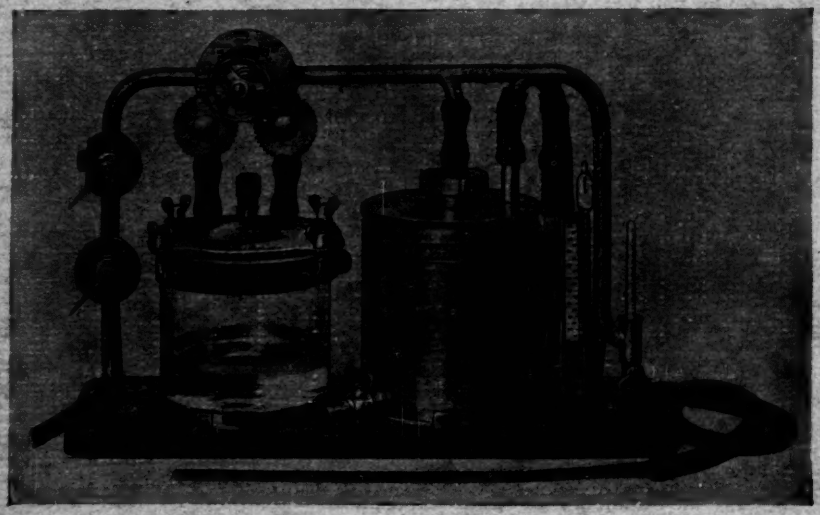
Intra-Tracheal Administration of Ether.

Made after the Design of Mr. R. E. KELLY, M.D., F.R.C.S., Liverpool

FULL DESCRIPTIVE CIRCULAR ON APPLICATION.

A MOST EFFICIENT APPARATUS FOR INDUCING ARTIFICIAL RESPIRATION.

ROTARY BLOWER WITH ELECTRIC MOTOR.

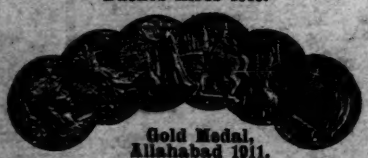


ETHERIZATION APPARATUS.

SECURING MANY ADVANTAGES IN THORACIC and GENERAL SURGERY, e.g.:—

In Thoracic Surgery, obviating the need for positive and negative cabinets. In Mouth, Nose, and Throat operations, avoidance of risk of the inspiration of blood, mucus, or pus. In Goitre operations, air is supplied below the Tracheal obstruction. In Head and Neck operations the anæsthetist is well away from the Surgeon. Owing to the slight respiratory movements, operations on the upper part of the abdomen are considerably facilitated.

GRANDS PRIX:
Paris 1900, Brussels 1910,
Buenos Aires 1910.



Gold Medal,
Allahabad 1911.

DOWN BROS. LTD., *SURGICAL INSTRUMENT Manufacturers,*

21 & 23, ST. THOMAS'S STREET, LONDON, S.E.
(Opposite Guy's Hospital.)

Factory: KING'S HEAD YARD, BOROUGH.

Telegraphic Address:
"DOWN, LONDON."
(*Regd. throughout the World.*)

Telephone—
HOP. 4400 (4 Lines)

PRINTED BY JOHN WRIGHT AND SONS LTD., BRISTOL.